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CHEMICAL & METALLURGICAL ENGINEERING

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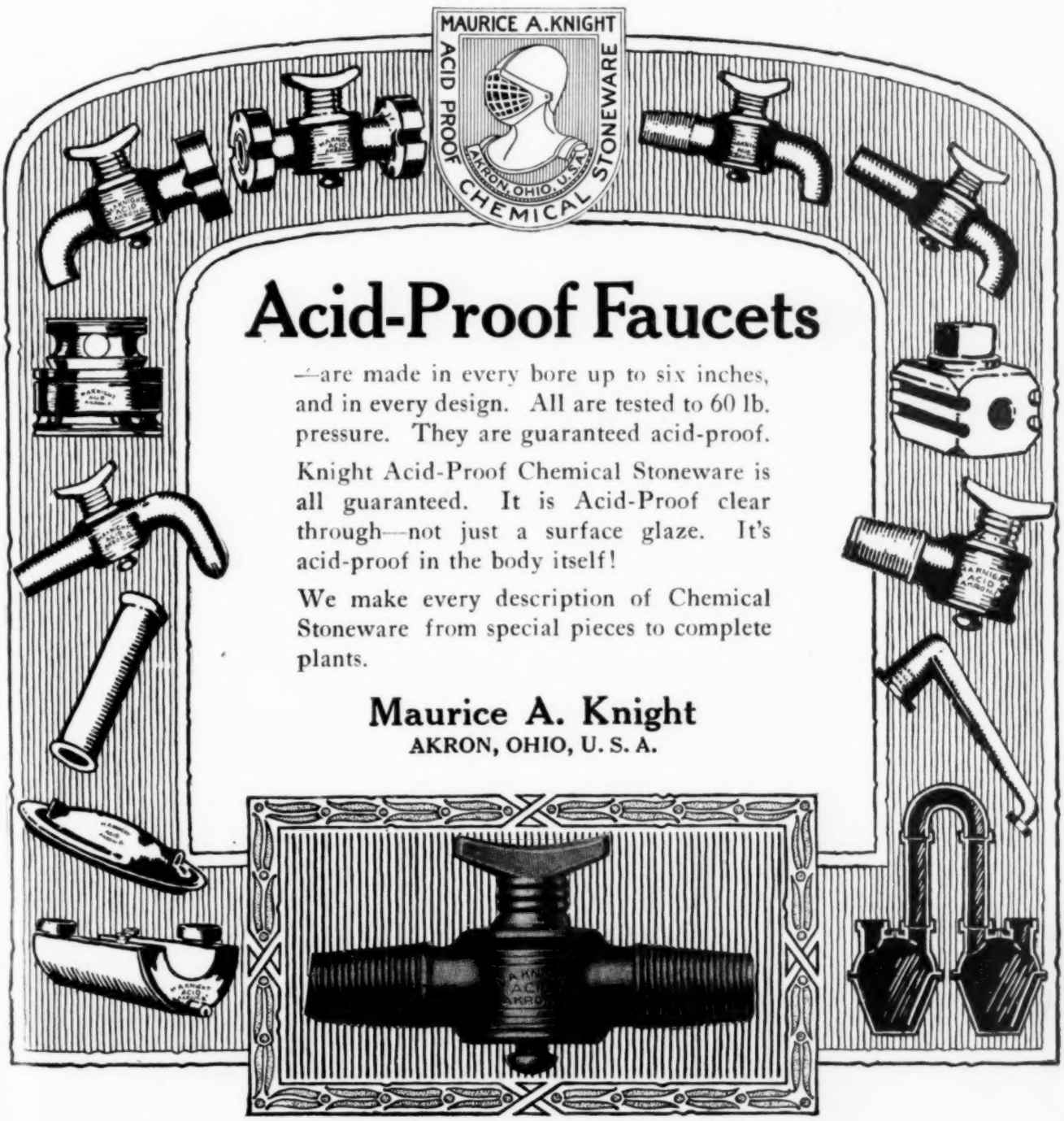

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A consolidation of
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Patent Royalties For Government Employees

THE report that Government employees are to receive a portion of royalties which may accrue from patents on inventions made or developed within Government time is worthy of note. Under the bill, which, as reported in our last issue, has passed the Senate, the Federal Trade Commission is to administer the patents and the President is to fix the percentage of royalties allowed to employed inventors. We take it that examiners in the Patent Office are not to participate in this privilege for the reason that a type of man that has thus far been pretty well avoided would be encouraged to enter that occupation. The temptation to file claims that would establish profitable interferences would invite the wrong men to come in as examiners.

Teaching and Government service appeal to some men of the very first rank. It is known beforehand that these occupations do not lead to wealth, as do occasional opportunities in industry. On the other hand, except in institutions of learning that suffer from the control of politics, a kind of academic freedom is provided, the annoynace of hasty and slipshod performances to beat a rival concern are avoided, the pay is regular, the domicile of a person so employed is likely to be in a pleasant place and there is a dignity attached to either calling that is at once agreeable and distinguished.

The Bureaus of Mines and of Chemistry are places where the value of such privileges may speedily develop. Many patents have emanated from these bureaus and have been assigned to the Government for the public welfare.

Whether or not the inventor should have any participation or share in the proceeds of his work done on Government time is a question of expediency rather than of ethics. The purpose of corporate research is for the benefit of the corporation, and this holds true for the people as well as for stockholders. But in industry a man is supposed to be able to look after himself, whereas in Government service he has no voice in making rules or contracts. He can accept or decline, but he cannot negotiate. We should like to see Dr. COTTRELL, for instance, made rich in spite of himself; for anyone who contributes as much as he has to human welfare and industrial progress is entitled to it. In England he would have been Sir FREDERICK long ago, while in Germany in the old days he would have been a real, simon-pure, genuine privy councillor "mit dem Prefix Excellenz" and probably ennobled into the bargain. It is men of this type, however, who are not even interested in the emoluments of office. They have a sane view of life, welcoming the luxuries of civilization but with no desire whatever for plutocratic luxuries. They do not want to keep their eyes at the point of strain to catch opportunities on the fly or to scrap with contemporaries for control or advantage. And the reward proposed is unlikely to be opulent. It is hardly enough of a bait to lure into the Government service shifty persons whose desire for profit is a constant hazard to character and who prefer dollars to a clear conscience.

Another point in its favor is that it will constitute an ever-present premium on the application of pure science to the use and benefit of society. Incentives of this sort have great potential value.

There may be serious objections to the proposal, but at present writing we are impressed with its advantages.

The Soviets At Work

UNDER the title, "The Soviets at Work," LENIN has recently made a statement that should be brought to the attention of every American. It deserves quotation in full:

"The bolshevists have destroyed capitalism, nationalized industry and formed workers' soviets. But Russia is still far from communism and a socialistic soviet republic.

"What the bolshevists have done so far was the easiest part. It was the destructive part. It required only force and decrees. The hardest part is still before them. Bolshevism will fail unless it can rebuild Russian industries and get maximum production.

"This cannot be accomplished under the original plan of bolshevism. The workers' soviets don't know how to run the factories and keep order. And the workers aren't yet willing to work for the same rate of pay for different kinds of work. The machine worker still wants more than the man with a pick; and the brain worker still wants more than the machine worker. Russia will not have communism until human nature is changed and each man is willing to work for the good of all instead of for personal gain.

"It will take years to change human nature by education and to teach workers to run factories by soviet methods. But in the meantime industry must be recognized and maximum output by both factory and the individual worker maintained.

"The only course before the bolshevist leaders is to take a step backward from the soviet state—to return to the old order. They must call in bourgeois experts at large salaries to run the factories. They must adopt the factory methods of capitalistic America.

"And the bolshevist leaders must go back still further. They must place the workers under iron discipline. They must make the hundreds and thousands of workers in each factory subject to the will of one man—the

bourgeois manager. The workers must be compelled to work their hardest."

Thinking men by the thousands have said that with an ideal human family socialism would be a most desirable system. LENIN, the proponent of Russian communism, from the depths of his terrible experience, approves those views.

If we could get a knowledge of what is transpiring in Russia into the minds of our loose-thinking elements it would lead them to improve what we have rather than advocate the Russian system—and to court the inevitable Russian chaos.

The Rule and Its Exceptions On the Properties of Lubricants

IF THERE is any actual rule for grading lubricants, a statement of it would embody the following five general principles: Purity, freedom from acid or corrosives, maximum adhesion to the surfaces to be lubricated, minimum internal cohesion or resistance to shear and stability under conditions of use. About a dozen laboratory tests have been devised to determine whether or not a given lubricant conforms to all of these specified properties. The application of this series of tests, however, has been to give a convenient means for comparing the qualities of an unknown lubricant with those that are found in lubricants that have proved most satisfactory after many years of actual use. Exceptions to indications of these tests have been found, so a knowledge of when the rule does not apply is of paramount importance to the rule itself.

The "germ" process recently introduced in England apparently is a good case for discussion. In this process mineral oils are compounded with from one to two per cent of rape-oil fatty acids, and the same reduction in the coefficient of friction is obtained as with twenty per cent of the neutral glycerides. From time immemorial, neutral rape-oil has been specified, so as to meet an acid test, which was actually designed to prevent the sale of refined lubricants from which the last traces of sulphuric acid had not been removed.

It is possible that the term acid will gradually come to have the qualification of "mineral" applied to it. At the same time, it may be expected that instead of removing all the unsaturated hydrocarbons, the lubricant refiner of the future may be a sort of synthetic chemist and make his anti-friction fatty acids right in the oil by adding carboxyl groups on to the open double bonds instead of sulphonating and removing them.

How They Do It Out in Kansas

GOVERNOR HENRY ALLEN recently addressed the Chicago Chamber of Commerce on the operation of the new industrial law in his state for preventing strikes. A special session of the Legislature was called during the coal strike last winter and a law was passed which would make it impossible for the recurrence of such wasteful events in the industries. The court which has been established is a court neither of arbitration nor of conciliation, but a court of justice operating as the chief representative of the State Government.

The law has not been exactly popular with a certain section of the labor element that has seemed inclined lately to run amuck.

However, a recent example of how the law functions is best described in Mr. Allen's own words:

> The other day there came to me a man representing the Maintenance of Way Railroad Craft in Kansas. He had just received from his national officer at Detroit orders to call out on strike the men who work in the maintenance-of-way crafts of the railroad organizations. He had also received orders to pass the word along as rapidly as he could. Now this man knew about this law, and he came to me and handed me the telegram, and said, "Governor, what will happen to me if I pass the word along to my locals?" I said, "Sit down, and we will read this law for a minute."
>
> I ran my finger underneath the lines that provided the penalty, and I read that to him, and in a moment I heard him swallowing his epiglottis, and he said, "Why, you could fine me $1,000, couldn't you, because I am the head of this organization?" "Well," I said, "read these other lines." "Why," he said, "you could put me in the penitentiary for a year," and I said, "Yes. Since you have come to me and have taken the trouble to consult me about the law on the matter, I am inclined to think that I would give you both barrels."

Looking backward over several decades, we may recall that other things have originated in Kansas which later became successful national measures dealing with difficult situations.

May the nation continue to look westward for future inspiration?

The Muscle Shoals Plant Should Be Operated

EDITORIALLY we have already commented upon the proposal of the War Department to operate the Muscle Shoals nitrogen fixation plants and expressed the opinion that the proposals of the War Department to this effect were sound. The criticism of this plan made before the Senate Agricultural Committee last week, as reported elsewhere in this issue, has not changed our general conclusions, although the additional light which has been thrown upon this subject is very interesting indeed.

It seems that there are several important reasons why the Government cyanamide plant at Muscle Shoals should be operated.

First, we believe that the nitrogen-using industries of this country can absorb the output of ammonia, nitrates and other forms of nitrogen available without being affected materially by the output of this small plant. Its output will form only a few percent of the total available nitrogen needed in this country and this certainly is not sufficient to materially affect our nitrogen markets.

Second, we believe that the War Department can best keep in touch with nitrogen fixation conditions and can gain most valuable experience only if it retains active interest and participation in some phase of these industries. The continuance of the Muscle Shoals plant and the investigations which will accompany this plant operation should give the Ordnance Department extremely valuable experience which will be much needed in case this country should ever again be confronted with serious war conditions.

Third, we believe that the losses to the Government will be less if it continues to operate this plant (at least for the near future) than if the plant is allowed to lie idle or is sold to any private interest either immediately or in the near future.

Fourth, we believe that the American chemist has sufficiently developed the art of converting cyanamide

into ammonia, and by oxidation of this ammonia into nitrates, to justify considering the product of this plant as available either as a substitute for ammonium sulphate or as a substitute for Chilean nitrate. Ammonia and nitrates are somewhat interchangeable, for the present state of knowledge makes it readily possible to convert ammonia into nitrate at costs that are not by any means prohibitive—especially in periods of emergency. The conclusion that there is a surplus ammonia capacity in this country which can do nothing to eliminate the need for importing Chilean nitrate is therefore not correct.

No policy, such as may have been proposed by some Government representatives, should be adopted permitting some Bureau to enter into the fertilizer market in competition with the American Cyanamid Company or other similar interests. General Government operation of manufacturing plants is not desirable where industries stand ready to care for the supply of needed materials. Any evident injustice against corporate interests that have co-operated with the Government in the development of their plants or processes during the war period should be certainly vigorously opposed. If the patents and the contracts under which the Muscle Shoals plant was constructed and operated are as satisfactory as the private interests seem to believe them to be, we see no reason why an observance of these contracts and patent rights will not amply protect individuals against Government interference except that in the field of ammonia resources or possibly in the field of nitrate supply the product of the Government's effort may for a brief period seem to be competing tonnage. However, this competition will not be either serious or long continued and we reiterate, therefore, that we still believe reasons entirely different from the commercial aspects of the matter fully justify continuance of the plan proposed for operation of this plant.

The Tonnage Output Of the Steel Industry

IT IS a good motto, and a useful one, that "obstacles were made to be overcome." The steel industry is now showing, in its tonnage outputs, the results of having learned fresh lessons during the war in overcoming obstacles. It is not long ago that what appeared to be a gloomy view of the future tonnage output of the industry was being taken by some classes of officials in steel companies, particularly in sales departments, but the actual tonnage outputs being made indicate that the steel industry is already on a fair road toward functioning better than ever, and producing a total output larger than it had been supposed capable of producing even under favorable physical conditions.

During the war there was much evidence of the steel industry straining itself to the utmost to produce a maximum of steel, and in the forms requisite for prosecuting the war, but when statistics were gathered of actual outputs they were, in the main, quite disappointing. Evidently there were few plants that produced as much steel in either 1917 or 1918 as in 1916, unless they had added to their facilities, and this made it appear that the steel producers, however desirous they were of bringing about the best results possible, were failing in their effort. There were very great difficulties, however, production being impeded at almost every step, not only by the transportation difficulties, which were notorious, but by many other things. There is good reason to infer that if the managers, superintendents and others directly responsible for mill and furnace operations had exerted themselves no more during American participation in the war than they had in 1916 the tonnage outputs of 1917 and 1918 would have been much less than they were. It is not alone the total tonnages of the two years that are to be considered, but also the difficulties under which those tonnages were produced.

A difficulty or obstacle overcome makes it possible to accomplish still more the next time there is a test. This is no new experience for the American steel trade. The market has been subject to its ups and downs. The trade had "either a chill or a fever," as was remarked by the late JAMES M. SWANK nearly a third of a century ago, while later ANDREW CARNEGIE observed that the steel industry was "either a prince or a pauper." There have been alternations whereby in one period, perhaps for a few months or perhaps for a couple of years, mills and furnaces would be strained to produce maximum tonnage, while in an intervening period there would be an insufficiency of orders, with specifications inconvenient for efficient rolling at that. At the average plant it has been the experience that almost month after month during a period of activity new tonnage records would be made, while from one period of activity to the next a great deal would be gained. It should not be surprising, therefore, if after the strenuous times of the war, forcing the devising of new expedients, the steel mills should be found now able to function better than they did in 1916. The actual capacity, measured in terms of trains of rolls and number of open-hearth furnaces of given dimensions, has of course greatly increased. In terms of steel ingots the increase in nominal capacity from the beginning of 1915 to the present time has been estimated at fully 40 per cent, only a relatively small portion of this capacity having been effective in 1916, the year that bears the palm of the past four for tonnage output in steel ingots proportionate to rated capacity.

Aggregate tonnages are not yet record breaking by any means, for there are transportation difficulties in the way, but individual cases show record-breaking outputs. A conspicuous case is that of the National Tube Company, furnishing no insignificant illustration since the company produces about 4 per cent of all the finished steel of the country. This company had a larger production in March, by a very comfortable margin, than in any previous month in its entire history.

The steel industry has been a leader in many respects, illustrating what can be accomplished by courage in adopting heavy machinery and trying new devices and methods. With the world at large, including the United States, suffering economically from inefficiency and what amounts to laziness, the steel industry of the United States will help the world if it sets an example now of producing steel at a greater rate than it had been assumed capable of, judging by past performance. By taking account of production in past periods of activity and allowing for new construction meanwhile, the steel ingot-producing capacity has been estimated in recent months at not over about 50,000,000 tons per annum, but it seems quite probable that in the near future a rate of output nearer 55,000,000 tons will actually be shown.

Readers' Views and Comments

Reversing the In and Out Ratio of the Chemical Engineers

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read with interest your editorial in your issue of Feb. 18, but cannot agree with your point of view. In fact, I believe that the other side of the shield looks entirely different. The American Institute of Chemical Engineers was organized after a preliminary campaign of a year by a committee of five, of which the writer was a member. A list of 700 names of chemists scattered over the United States was prepared as being possible members of the new society. Correspondence with this list was carried on for a year with the object of learning if there was a demand for the organization of the new society. A meeting was held in New York at which the question was discussed, after which a mail vote was taken.

As this was favorable by a large majority, the committee drafted a constitution and effected organization at Philadelphia, June 22, 1908, with forty charter members. During the year sixty more of the 700 joined the organization. Many of the 700 were found on investigation to be qualified by reputation only; others decided not to join the society. The society continued to grow steadily and now has a membership of 357.

You state in your editorial that there are "six outs" to "one in," which would mean that there are 2,500 chemical engineers in the United States who would be eligible for membership in the American Institute of Chemical Engineers. You also state that the "one in" has done nothing to reverse the ratio of membership.

I cannot agree with either of these statements. The Institute has met in various large centers of chemical industry, where many of the "six outs" must reside in order to gain a livelihood by this profession. Before each meeting the local committee has carefully gone over the list of chemists and engineers residing in the section and made a list of the men who could qualify for membership. These men have been invited to apply for membership and generally have done so and been elected.

In this manner a search has been made by a group of local chemical engineers for members in the following centers: Chicago, St. Louis, Cleveland, Detroit, Buffalo, Troy, Boston, Savannah, Los Angeles, San Francisco, Washington, Baltimore, Philadelphia and New York. Undoubtedly younger men are continually coming forward and men in out-of-the-way places are overlooked, but it seems unlikely that six men could have been overlooked for every one who was found. Members of the society are also constantly sending in names or inducing their friends to apply for membership.

The membership of the society will no doubt keep increasing as the ever-growing number of graduates of the chemical courses of our universities and technical schools gain experience and rise into positions of responsibility or demonstrate their ability, but I doubt if a very large and sudden increase in membership is possible unless the standards of membership are lowered.

There is no probability that the present membership will consent to the lowering of the professional or ethical requirements for membership. The society will be of the greatest service to the chemical industry and our country by locating the "outs" who meet the standards of the society and making them desire to become "ins." With its present membership the society can hold very successful meetings and meet all its financial obligations. Nevertheless, it is making an earnest effort to reach all who can qualify.

Another possible method of quickly increasing its membership is to offer another grade of membership such as that of associate membership for those who cannot meet all the professional requirements of education and experience, but who conform to the requirements of the code of ethics. This was considered some years ago, but at that time was not considered advisable.

In this letter I am expressing my personal view of the situation, which does not necessarily reflect the view of the American Institute of Chemical Engineers as a body, as there are quite a number of members of the Institute who have expressed views along the lines of your editorial. J. C. OLSEN.

Brooklyn, N. Y.

Acid Fumes on Riverside Drive

To the Editor of Chemical & Metallurgical Engineering

SIR:—Your amusing comment on "Acid Fumes on Riverside Drive" should be taken in good part by residents on or near the Drive, but I wish to add my plea that something effective be done about it. Being a chemist myself and familiar with all sorts of odors, I am compelled to say they are horrible.

It may be all very well to pass facetious remarks about these assorted odors, and good-humoredly "pass the buck" as to who is to blame, as well as to comment that it is too bad about the "pampered rich" in this section—including several less pampered ones. The point would seem to be that chemistry is a science to alleviate the disagreeable in life as far as possible, rather than to add to it.

I confess that, though living a short distance away from the Drive, only the other night, having just retired, I unexpectedly inhaled several lungfuls of these "delightful odors"—or such as one may cultivate himself to so recognize, as your editorial expresses it—and I enjoyed it and felt impelled to draw deep thrilling drafts of it, as much as most people enjoy breathing sewer gases and those from defective flues. I can heartily recommend the experiment to you.

Incidentally, it may also be beneficial to terraces on Riverside Park to be sprayed with a solution of sulphuric acid 1 : 6,000, which on evaporation would become concentrated to some extent and promote a healthy growth to grass-seedlings. H. S. MUDGE.

New York City.

The Elastic Development of Steel

Description of a Research Undertaken to Salvage a Large Number of Unsatisfactory Bayonet Blades, Which Developed the Fact That Unusually High Strengths Could Be Produced in Medium and High Carbon Steels by High Drawing After Quenching

By SIDNEY CORNELL

MILITARY men in the Ordnance Departments of the United States and the Allied nations devised tests for semi-finished and finished munition parts that were often unnecessarily and unusually severe, many times representing no strain to which the part would be subjected in actual service. Contracts were taken by our manufacturers with full knowledge of these requirements as specified and stated, but often without knowledge as to what it meant to meet such required tests, and financial losses resulted which will be remembered for a long time. It seems that a more thorough knowledge of the useful strength of metal generally, rather than laboratory tests for condition, might be of immense service in industry and of continual value in the manufacture of commercial goods. Viewed in this light the severe requirements of governments for their war tools can be taken as beneficial, for tests were conducted that commercially never would have been attempted, in order to develop properties in metal parts so as to pass such tests.

Maximum Strength Not at Highest Hardness

Ordinarily the full strength of steel is supposed to be developed at the proper hardening temperature without let-down of the temper. It is also generally assumed that each let-down, or draw, after that hardening weakens the steel, in the sense that it is then not as strong as in the hardened condition.

This view is erroneous, as was discovered by the writer in exhaustive tests made on finished, semi-finished and raw stock required for the manufacture of rifle parts. The useful strength of steel is proportional to the elastic limit of that steel, and inasmuch as this property is susceptible to heat treatment, the most resilient steel can be defined as one that fills the greatest usefulness. The greatest elastic limit, and incidentally also the maximum tensile strength, is not obtainable in steel when hardened only, but is found in the hardened steel when drawn at a more or less closely limited drawing temperature.

Flexure Tests for Bayonets

The English Government required a flexure test for bayonet blades—which subsequently was adopted by the United States—that the hardened and drawn bayonet blade be bent axially 2½ in. (63.5 mm.) out of the vertical, and that the blade must restraighten without a kink or long bow in the cutting edge or back visible to the eye. A vertical lever is used to perform this test, and a pressure of approximately 110 lb. (50 kg.) on the end of a bayonet is required to effect the flexure. The vertical foreshortening of the blade to give a maximum bow of 2½ in. amounts to ¾ in. (19.05 mm.). The test was originally conducted by bending both ways, right and left. It was found that a set in one direction would be corrected by a corresponding set in the other direction, yielding a blade at the end that would pass inspection as straight and of satisfactory temper. Finally instructions were given which required the blade to be inspected after each flexure, right or left, yet adhering to the requirements of perfect straightness.

The Remington Arms Union Metallic Cartridge Co. had serious difficulty in 1916 in meeting these and other requirements. English inspectors would reject blades that were too stiff and which required over 120 lb. (55 kg.) on the vertical lever, although stiff bayonets, so called, usually broke in the test. On the other hand, any blade that set, kinked or had a long bow in it after the flexure test was condemned as "soft." Matters progressed so that although the production of machined, hardened and drawn bayonet blades amounted to over 10,000 per day, the acceptance on the part of the English inspectors became less and less until finally no production in bayonets was made. An accumulation of manufactured but not accepted blades finally amounted to over 1,000,000 English bayonets.

Expert heat-treating recommendations from various experts were used during this time, but no satisfactory blades were made. Irregularities in the steel used could not be blamed for the trouble, as satisfactory blades in quantity had been produced from steel of the same composition. Heat treatment obviously was at fault, and the contentions of the English inspectors in calling blades "soft" undoubtedly had a bearing on the methods of attack on the part of the heat treaters in trying to solve the problem. As a matter of fact the term "soft" was not the correct definition of the trouble.

Characteristics of Rejected Bayonets

The heat treatment given the blades was as follows: Harden in a lead bath at 1,500 reg. F. (816 deg. C.), quench in oil, draw temper at 575 deg. F. (302 deg. C.) in a niter bath for 3 min., and quench in water, followed by a straightening operation by hand.

With a million scrap bayonets to reclaim, a thorough investigation was inaugurated. The steel was found to vary considerably in composition; for instance, carbon varied from 0.75 to 0.95 per cent. Other ingredients in the steel were practically constant, chromium varying from 0.33 to 0.37 per cent. As mentioned before, the composition of the steel could not be blamed for the trouble, as bayonets had been made from all lots that were acceptable, and while all heat treatments in reason had been tried, nothing at this stage would yield a bayonet in quantity that would pass English inspection requirements. Among rejected bayonets there were naturally those in all stages of manufacture, as far as the heat treatment was concerned, including those that were hardened only, those that had not been

hardened and those that had been hardened at 1,500 deg. F. and drawn at 575 deg. F. (816 and 302 deg. C.).

Starting with raw stock, various hardening temperatures were tried upon duplicate pieces, determinations being made on the various physical properties of the steel. The working temperature selected was 1,480 deg. F. (804 deg. C.) as the one which produced the best

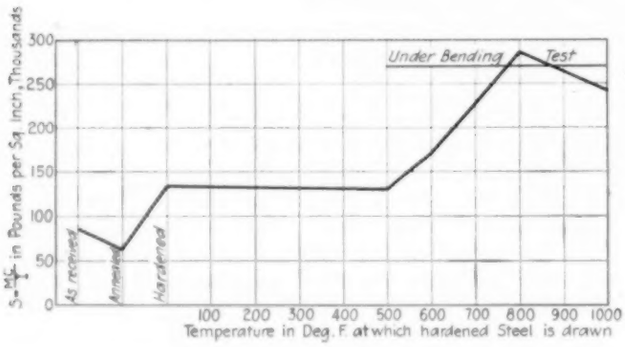

FIG. 1. ELASTIC DEVELOPMENT OF STRENGTH OF BAYONET BLADE STEEL

condition of the hardened steel. This was not radically different from the previous shop practice. To carry the matter further, ultimate tests were made on bars which had been hardened at 1,480 and drawn at various temperatures, and the results plotted. Indications from these tests gave the result that a hardened bar had the greatest elastic limit when drawn at 800 deg. F. (427 deg. C.), very much higher than ordinarily thought reasonable.

A test lot of bayonets that had been rejected as being "soft" and which had been hardened at 1,500 deg. F. (816 deg. C.) and drawn at 575 deg. F. (302 deg. C.) were redrawn at 750 deg. F. (399 deg. C.) and submitted to the English inspectors, who accepted the

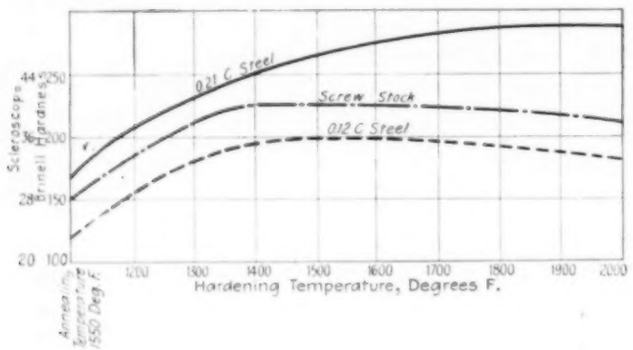

FIG. 2. EFFECT OF HARDENING LOW-CARBON STEELS AT VARIOUS TEMPERATURES

blades. This eventually became known as a "stiffening process." Various precautions in relation to hand straightening were adopted, and on this so-called "stiffening draw" the bayonet department became productive again, the majority of the 1,000,000 rejected bayonets finally being accepted.

A more complete analysis as applied to the strength of the British bayonet blade follows:

When the bayonet is subjected to the ¾-in. flexure test it acts as a column for which the formula is

$$Px = \frac{IS}{C}$$

P = load, in this case 110 lb.

x = deflection; when foreshortened ¾ in., is 2½ in.

I = moment of inertia about neutral axis.
= 0.0002206 for the average section of the blade.
= 0.0001296 for the weakest section of blade.

C = distance to extreme fiber, average value, 0.114.
= 0.127 at weakest point.

S = extreme fiber stress in lb. per sq.in.

With a blade that met the English requirements of applied load of 110 lb., producing a ¾-in. foreshortening and a 2½-in. deflection in the blade, the maximum value of S is 269,000 lb. (18,912 kg. per sq.cm.).

It was observed that when hardened but not drawn blades were tested they had a tendency to bend slightly before breaking, but that they had no power of recovery. When drawn at 500 deg. F. (260 deg. C.) the recovery after imposing a load was first evident, in-

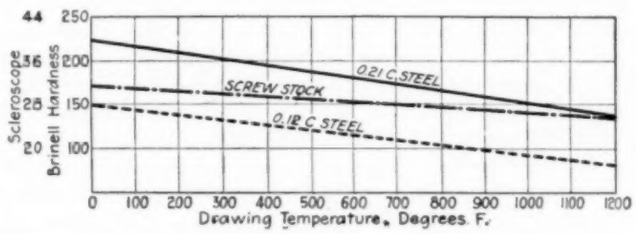

FIG. 3. EFFECT OF ANNEALING HARDEST BARS OF FIG. 2 AT VARIOUS TEMPERATURES

creasing proportionally up to a maximum of 800 deg. F. (427 deg. C.) and then lessening in intensity.

Fig. 1 shows the results of tests on this steel, using duplicate samples for check in all cases, conducted with the object of meeting the theoretical maximum fiber stress under a 110-lb. (50-kg.) load on a bayonet. The maximum elastic limit possible to develop in an extreme fiber by heat treatment is 288,000 lb. per sq.in. (20,200 kg. per sq.cm.), whereas the theoretical elastic limit imposed by the machine is 269,000 lb. per sq.in. Thus there is a leeway of only 18,000 lb., or 6 per cent.

Principal data regarding the bayonet steel follow:

Average Analysis: Carbon, 0.86; manganese, 0.33; silicon, 0.24; phosphorus, 0.017; sulphur, 0.013; chromium, 0.37.

Average Physical Properties: Tensile strength, 97,000; elastic limit, 80,000; elongation, 27 per cent; reduction, 60 per cent.

Ar = 1,260 deg. F.; Ac = 1,335 deg. F.

Standardized Heat Treatment: Pack anneal at 1,550 deg. F. for 22 hr.; lead hardening at 1,500 deg. F. for 4 min.; oil quench; niter draw from 575 deg. F. for 3 min.; first straightening in lead to straw color; second straightening in lead to blue color; stiffening in niter at 750 deg. for 2½ min.; water quench.

Following the important practical results obtained by elastic development in bayonet steel, equally important results were obtained through a similar study of the properties of the various grades of steel used in the manufacture of rifle components. The steels for this use were classified into seven grades, but elastic developments were not made on the first three grades, these being low-carbon material. However, hardening tests were made, and effects of drawing at different ranges were recorded in Brinell hardness with enlightening results.

Fig. 2 shows effect of hardening Grade 1 steel at different temperatures, and Fig. 3 the Brinell hardness after the hardened material had been drawn.

The analysis and physical properties of this grade follow:

C	0.12	Tensile strength	53,800
Mn	0.34	Elastic limit	35,900
Si	0.05	Elongation, per cent	33
S	0.027	Reduction, per cent	71
P	0.013		

Examination of the dotted lines shows the evident fact that quenching from an increasingly higher temperature increases the Brinell hardness of even a 12-point steel up to a flat maximum somewhere between 1,500 to 1,700 deg. F. (800 to 940 deg. C.), above which the hardness is less than after a lower quenching. Taking bars which had received their maximum hardness, annealing at progressively higher temperatures reduces the Brinell hardness in a linear ratio.

Grade 2 steel (screw stock) had the following chemical analysis and physical properties:

C	0.15	Tensile strength	62,200
Mn	0.65	Elastic limit	42,300
Si	0.026	Elongation, per cent	29
S	0.104	Reduction, per cent	61
P	0.081		

Its Brinell hardness after a series of quenchings and systematic drawings is plotted in Figs. 2 and 3 in dot and dash. The characteristics of the curves are exactly similar to those of soft-low-sulphur steel, (Grade 1).

Grade 3 steel of the following analysis was treated in the same manner:

C	0.21	Tensile strength	67,000
Mn	0.45	Elastic limit	48,000
Si	0.11	Elongation, per cent	28
S	0.039	Reduction, per cent	65
P	0.035		

Fig. 2 shows that its hardness, originally higher than the two other steels, increases at a rate which indicates a flat maximum near 2,000 deg. F., where the quenching experiments stopped. However, the effect of drawing such metal after a quenching from

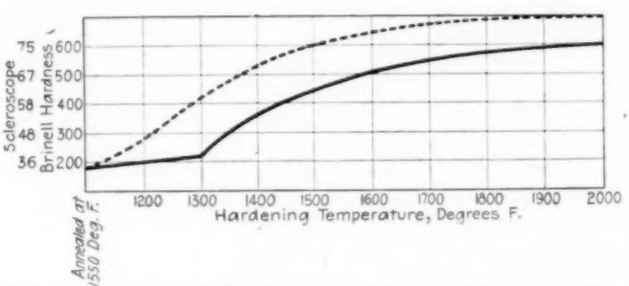
Scleroscope
Brinell Hardness
75 67 58 48 36
600 500 400 300 200
1200 1300 1400 1500 1600 1700 1800 1900 2000
Hardening Temperature, Degrees F.
Annealed at 1550 Deg. C.

FIG. 4. HARDNESS VERSUS HARDENING TEMPERATURE CURVES

Full line represents 35-point carbon steel. Dotted line represents smokeless barrel steel.

1,650 deg. was more pronounced than before, as indicated by a steeper slope of the line representing hardness against drawing temperature.

Determinations of elastic development were made on Grade 4 steel and the grades to follow. The rise in strength under appropriate heat treatment is plainly evident. The properties of Grade 4 in its condition as received is as follows:

C	0.35	Tensile strength	90,300
Mn	1.28	Elastic limit	61,700
Si	0.19	Elongation, per cent	22
S	0.034	Reduction, per cent	64
P	0.054		

Fig. 4 shows in a full line the hardness after annealing at 1,550 deg. C. and after quenching this normalized material from various temperatures. The hardness is shown to rise continually up to the highest temperatures experimented with. Samples after hardening from 1,650 deg. C. were then drawn at various temperatures. Fig. 5 shows the results in a full line. Hardness in this case is a mean line between a higher graph showing scleroscope numbers and a lower graph the Brinell

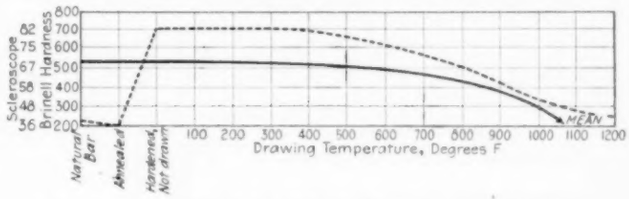

FIG. 5. DECREASE OF HARDNESS UPON DRAWING

Full line represents 35-point carbon steel. Dotted line represents smokeless barrel steel.

numbers. For instance, the scleroscope hardness of the hardened specimen drawn at 600 deg. is 70, while the Brinell number is 480.

A number of transverse specimens were then hardened by oil-quenching from 1,510 deg. F. These were then drawn at various temperatures, tested, and the physical properties under the ordinary slow deflection test determined and plotted as in full lines in Fig. 6. Contrary to the general assumption, reheating even to relatively high temperatures increased the ultimate strength and elastic limit.

Grade 5 steel is the so-called smokeless barrel steel on

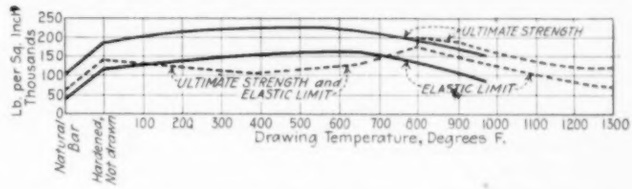
Lb. per Sq. Inch
Thousands
250 200 150 100 50
ULTIMATE STRENGTH
ULTIMATE STRENGTH and ELASTIC LIMIT
ELASTIC LIMIT
100 200 300 400 500 600 700 800 900 1000 1100 1200 1300
Drawing Temperature, Degrees F.
Natural Bar
Hardened, Not drawn

FIG. 6. ELASTIC DEVELOPMENT FOR STEELS SHOWN IN FIGS. 4 AND 5

Full line represents 35-point carbon steel. Dotted line represents smokeless barrel steel.

which a great deal has been written, and which has caused a great deal of trouble in its fabrication. Its analysis is:

C	0.53	S	0.052
Mn	1.25	P	0.064
Si	0.27		

The physical properties of the steel as received and after routine heat treatment are:

AS RECEIVED

Tensile strength	120,300	Elongation, per cent	16
Elastic limit	73,000	Reduction, per cent	44

HEAT-TREATED BARRELS

Tensile strength	132,400	Elongation, per cent	12
Elastic limit	115,500	Reduction, per cent	48

This steel when hardened from different temperatures gives the results plotted in Fig. 4 in dotted lines, the Brinell and scleroscope being the measures of hardness. A line is traced quite similar to that for Grade 4 steel, but somewhat higher on the hardness scale.

The bar or billet as it came from the rolling mill, after it had been annealed and hardened from the best temperature and then drawn from a series of rising temperatures, gave results shown dotted in Fig. 5. Results again are quite similar to those for steel of the previous grade, shown in full lines. However, when subjected to elastic development, the elastic limit and

ANALYSES AND PHYSICAL PROPERTIES OF STEELS STUDIED

Grade	C	Mn	Si	S Maximum	P Maximum	Tensile Strength	Elastic Limit	Elongation Per Cent	Ac_1 Deg. F.	Ar_1 Deg. F.	B.t.u. at Ar_1
1	0.025–0.15	0.50	—0.05	0.06	0.06	35,000– 50,000		25	1345	1225	4.6
2	0.10 –0.20	Commercially known as Screw Stock		....	....	Approx. 40,000		..	....	....	....
3	0.20 –0.30	0.50	0.05–0.20	0.05	0.04	40,000– 60,000		20	1340	1248	5.9
4	0.30 –0.40	1.10–1.40	0.15–0.30	0.06	0.06	50,000– 75,000		20	1314	1195	6.4
5	0.50 –0.60	1.00–1.30	0.15–0.25	0.06	0.08	113,800–142,225	Min. 92,450	10	1330	1195	8.9
6	0.60 –0.70	1.10–1.40	0.15–0.30	0.06	0.06	75,000–100,000		15	1355	1215	11.1
7	0.90 –1.00	0.25–0.45	0.10–0.20	0.03	0.025	75,000– 90,000		12	1360	1280	11.7
8*	0.70 –0.80	0.30–0.40	0.10–0.25	0.03	0.03	Approx. 250,000		..	....	....	....

* Commercially known as music wire.

ultimate strength (practically the same value) increase up to a drawing temperature of 800 deg. F., and then decrease. This is shown in Fig. 6 in dotted lines, and its difference from that of Grade 4 is striking.

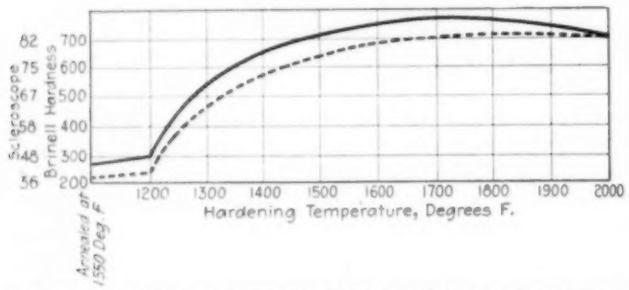

FIG. 7. HARDNESS VERSUS HARDENING TEMPERATURE FOR HIGH-CARBON STEEL

Full line represents Grade 6 (0.60 carbon). Dotted line represents Grade 7 (0.92 carbon).

Grade 6 steel of higher carbon content analyzed:

C	0.60	Tensile strength	109,800
Mn	1.25	Elastic limit	60,300
Si	0.275	Elongation, per cent	17
S	0.037	Reduction, per cent	51
P	0.062		

The effect of hardening is shown in Fig. 7, temperatures up to 2,000 deg. F. being used, and the Brinell and scleroscope the measure.

The effect of drawing at different temperatures is shown in Fig. 8 in full lines. Note that this steel comes nearest to obeying the rules as indicated by various authorities, viz., that the hardened and not

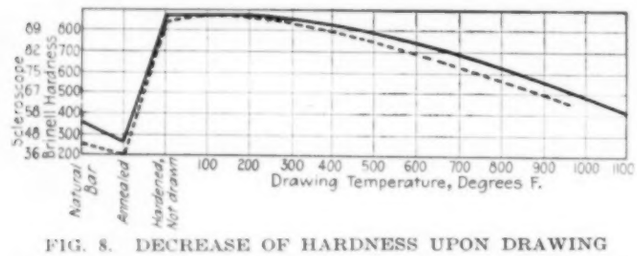

FIG. 8. DECREASE OF HARDNESS UPON DRAWING

Full line represents Grade 6 (0.60 carbon). Dotted line represents Grade 7 (0.92 carbon).

drawn steel is the strongest. However, the measure is Brinell hardness, not elastic limit or tensile strength. That in many cases there is not a constant relation between these properties is shown in Fig. 9. Here the elastic development is clearly shown, this steel reaching a maximum strength when drawn at 800 deg. F.

Grade 7 steel has the following analysis:

C	0.92	Tensile strength	79,700
Mn	0.36	Elastic limit	50,300
Si	0.18	Elongation, per cent	25
S	0.023	Reduction, per cent	55
P	0.022		

The effect of hardening temperature is illustrated in Fig. 7 in dotted lines, the measure again being Brinell and scleroscope.

The effect of drawing temperature is given in Fig. 8, while the elastic development is clearly illustrated in Fig. 9. The ultimate strength increases in a well-defined relationship to the elastic limit; maximum development is attained at approximately 650 deg. F.

It is believed that the foregoing data in relation to the effect of temperatures on the heat treatment of steel will be new to many persons, and it will fill a need in the heat-treatment department of smaller plants where facilities for conducting such an investigation are not at hand. The range of composition of the steels covers from 0.10 to 1 per cent carbon in eight steps, so that properties of any steel as usually met with can be approximated.

The analyses of the steels as given represent averages of not less than twenty-five check analyses conducted on the material as received. The specified chemical re-

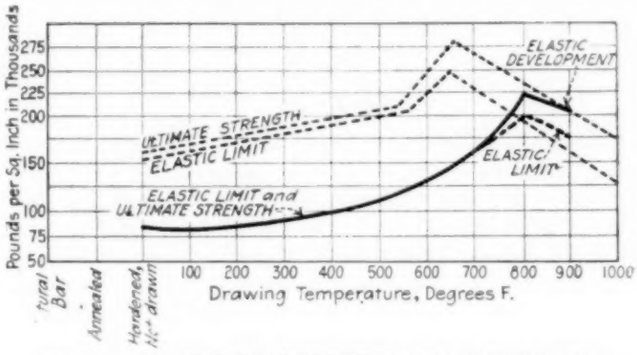

FIG. 9. ELASTIC PROPERTIES OF HARDENED AND DRAWN STEELS

Full line represents Grade 6 (0.60 carbon). Dotted line represents Grade 7 (0.92 carbon).

quirements for the seven grades of steel discussed were as tabulated above, attention also being drawn to the Ac_1 and Ar_1 points as determined, and to the B.t.u. liberation at the Ar_1 point as calculated.

CONCLUSION

Heat treatment is far from being an exact science. There must be a mass of data in existence in this country the authors of which show a hesitancy toward presenting it to criticism in the technical press. It is suggested that these authors present their data, and that they receive a fair reception on the part of editors. Many articles on heat treatment are remarkable by their similarity, dealing with metallography in particular, and it is thought that the reason for this state of affairs is that all of the men engaged in "heat treating" for a livelihood know that there is no real working treatise on the subject of "heat treatment of steel," and the writers among them are making a start at one that will be complete. Why not publish observed facts, which may bring about discussion and undoubtedly will be a step toward betterment in this art which never can be absolutely scientific?

New York City.

Electric Furnace Smelting of Montana Manganese Ores*

Balance Sheet of 10-Day Electric Furnace Test—Discussion of Slag and Furnace Losses, Together With a Method of Calculating Charges—Description of Electric Furnace Plant at Great Falls

BY E. S. BARDWELL
Metallurgist, Anaconda Copper Mining Co.

DURING the year 1918 there was produced in the United States 304,366 long tons of manganese ore containing over 35 per cent manganese[1]. Of this amount, Montana alone produced 199,932 tons, or over 65 per cent of the total tonnage. Practically all of this ore came from the Philipsburg and Butte districts; 127,415 tons from the Philipsburg district, 72,381 tons from the Butte district, with only 136 tons reported as coming from other parts of the state. The armistice caused an immediate curtailment of manganese mining in Montana due to the ability of the Eastern steel plants to secure supplies of manganese ore again from foreign sources.

Prior to 1914 less than 2 per cent of the total high-grade manganese ore used in the United States was mined in this country. The manganese production of the State of Montana in 1918 was greater than the total imports to this country for the year 1911 and would represent a substantial percentage of this country's normal requirements.

In view of these facts, the importance of this potential source of manganese cannot fail to be recognized and a discussion of the problems of smelting these ores in the electric furnace should be of interest.

CHARACTER OF ORES

The Montana ores are low in phosphorus and iron and admirably suited for the production of 80 per cent ferromanganese.

In the Butte district the Emma mine is the chief producer. The output of this mine during the war reached a maximum of 10,000 tons of rhodocrosite ore a month, the greater part of which was shipped to Eastern consumers.

A typical analysis of this ore would be as follows:

	Per Cent		Per Cent
Moisture	2.61	BaO	0.00
MnO	46.87	CO_2	33.56
FeO	2.68		
SiO_2	6.19		95.70
Al_2O_3	1.18	Undetermined	4.30
CaO	0.00		
MgO	2.61		100.00

The Philipsburg ores differ from those of the Butte district in that they are higher in silica and contain manganese principally in the form of the psilomelane, a hydrated oxide of manganese of more or less indefinite composition.

An average analysis of this ore would be about:

	Per Cent		Per Cent
Moisture	9.73	BaO	.....
MnO_2	50.10	Loss on ignition	12.80
MnO	3.83		
Fe_2O_3	2.90		99.44
SiO_2	18.07	Undetermined	.56
Al_2O_3	2.01		
CaO	.....		100.00
MgO	.....		

By washing it is possible to reduce the silica content of the Philipsburg ores to at least one-half the percentage stated above, with a corresponding increase in manganese content.[2]

ELECTRIC FURNACE PLANT AT GREAT FALLS, MONT.

During 1918 the Anaconda Copper Mining Co. erected at Great Falls, Mont., an electric furnace plant capable of producing ninety tons daily of 80 per cent alloy. The first of five furnaces was started in September. Three furnaces were ready for operation at the time the armistice was signed, shortly after which time operation ceased due to lack of market for the product.

The furnaces consist of an open-top, shallow brick shaft 28 x 14 x 9 ft. (8.5 x 4.3 x 2.7 m.) in outside dimensions. Outer walls are of red building brick with an inner firebrick lining. This shaft has a tamped lining composed of dead-burned magnesite with pitch as a binder. The tamped lining is 3 ft. (91 cm.) in thickness at the bottom of the crucible and is brought up the sides to a point about 18 in. (46 cm.) above the tap-hole level. Cooling pipes are provided in the bottom through which air for cooling the bottom is circulated. Inner dimensions of the crucible at the middle section are 22 x 9 ft. x 6 ft. deep (6.7 x 2.7 x 1.8 m.). The furnaces are operated on 60-cycle, three-phase alternating current. Two 24-in. (61-cm.) round amorphous carbon electrodes are used in a common holder on each phase. Electrodes are spaced 3 ft. (0.91 m.) between centers in the holders and the pairs about 5 ft. (1.52 m.) on centers.

The holders originally provided were discarded on account of mechanical difficulties and a simple holder devised made in two entirely independent halves held together by pins and wedges. A long "fish-tail" cast integral with the holder makes it possible to avoid bringing cables out over the furnace where they will be subjected to the hot gases. Water cooling is brought about by a coil of pipe properly formed and cast in, and water connections for each half are independent. The holder is supported by yokes which serve to keep the chains used for raising and lowering the holders up out of the heat. Winches for raising and lowering the electrodes are placed upon the bridge supporting the holder and electrodes, which bridge is insulated from the furnace superstructure by means of vitrified brick interposed between. No trouble was experienced from failures of insulation during the time the furnaces were operated. The holders themselves were cast in sand molds from phosphor-copper and require practically no machine work. We found the contact surface ample and the holder sufficiently flexible

*Paper presented at the thirty-seventh convention of the American Electrochemical Society, Boston, April 9, 1920.

[1] *Mineral Industry*, vol. 27 (1918), p. 460.

[2] A brief account of concentrating methods employed is given in CHEM. & MET. ENG., vol. 18, p. 625, June 15, 1918.

to take care of the inequalities in size often existing between the two electrodes in the holder. A loosely fitting sheet steel sleeve was provided to slip down over the electrode. This rested on top of the holder and prevented the electrode being eaten away above the holder by the hot gases.

When slipping electrodes the wedges were easily loosened, the holder raised and again clamped. The time required for slipping electrodes was not over 10 min. No attempt was made to protect the electrode exposed between the holder and the charge except to keep the holder as close down to the top of the charge as was feasible.

Substation

The substation, from which electrical energy is supplied to the furnaces, is located immediately back of the furnaces. It received power at 110,000 volts from nearby hydro-electric plants of the Montana Power Co. Two 12,000 k.v.a. General Electric transformers serve to reduce the voltage from 110,000 to 6,600 volts, at which voltage it is delivered to the furnace transformers. Each furnace is equipped with one General Electric polyphase transformer rated at 5,630 k.v.a., provided with taps on the high tension side for 85, 100, 115 and 130 volts. The furnaces were operated with a no-load voltage of 115 volts. The average input under these conditions was 3600 kw. The power factor was about 80 per cent.

The operating panels are arranged in a gallery overlooking the furnaces. Provision is made for either hand or automatic control. The automatic regulators are of the General Electric type originally designed to operate on current. We found it advantageous, however, to keep the voltage on the separate phases balanced rather than the current and the necessary alterations were made in the apparatus to enable us to regulate on the voltage between phases and ground. With this change the automatic control proved highly satisfactory, holding the load constant under all conditions met with in operation with very little attention on the part of the operator.

Charge Mixing

The weighing and mixing division is so arranged that four operators can, in one shift, weigh and mix sufficient charge to keep five furnaces in operation for 24 hr. This would hardly be feasible were the plant treating a large variety of ores, but given a constant supply of ore of a uniform grade, little or no difficulty has been experienced. Mixed charge is delivered by belt conveyors to the mixed charge bin, whence it is taken in boats by traveling crane and dumped into charge hoppers at the furnace.

The charge consists of ore, limerock, coal, coke and iron ore. The only manganese ore treated at Great Falls is the Butte rhodocrosite ore from the Emma mine. The charge treated was as follows:

	Lb.		Lb.
Ore	500	Coke	50
Limerock	90	Iron ore	12
Coal	100		

When the furnaces were first started coal only was used as a reducing agent. We soon found, however, that owing to the fact that the rhodocrosite decrepitates when heated this gave us too compact a charge. Primarily to do away with this difficulty, we substituted for a part of the coal an equivalent amount of blast-furnace coke based, of course, on the relative fixed carbon content of the two materials. With this change the furnace operated very smoothly with only occasional boils. Coke alone was tried, but with this we could not keep the electrodes down in the charge. The proportions of coal and coke indicated above were finally determined upon as being the best under our conditions.

The furnaces are tapped at intervals of about 1½ hr. The slag and metal run into ladles, the slag is skimmed into a slag sluice and the metal cast by machine.

The plant was operated for such a short time and under such adverse conditions that it is impossible to give accurate metallurgical results. The results were on the whole, however, satisfactory. The loss by volatilization was not over 15 per cent and the recovery of manganese in metal between 75 and 80 per cent.

Electric Furnace Test on Montana Ores

Materials

The ore used in the test about to be described consisted of a half and half mixture of ores from the Philipsburg and Butte districts. This material was very carefully bedded, sampled and analyzed. The analysis of the mixture gave results as follows:

	Per Cent		Per Cent
Moisture	5.03	BaO	0.03
MnO_2	23.92	MgO	1.15
MnO	26.37	CO_2	16.67
FeO	1.14	Comb. H_2O	6.43
Fe_2O_3	1.40	Undetermined	2.43
SiO_2	13.48		100.00
Al_2O_3	1.95		
CaO	.....		

Coal was used as a reducing agent. This coal was of the following analysis:

	Per Cent		Per Cent
H_2O	7.82	Al_2O_3	0.73
Fixed carbon	54.43	MgO	0.34
Volatile hydrocarbons	31.73	Undetermined	0.67
FeS_2	1.84		
SiO_2	2.44	Total	100.00

As flux a very pure marble was employed. This contained 55.0 per cent CaO and 43.2 per cent CO_2.

It was necessary to add iron in order to make 70 per cent ferromanganese. The iron was added in the form of turnings which were not analyzed but which for the purpose of the test we assumed to contain 100 per cent iron.

The Furnace

The furnace upon which this test was conducted was of the rectangular open-top type. It consisted of a steel shell 18 ft. x 9 ft. x 8 ft. 8 in. (5.5 x 2.7 x 2 m.) outside dimensions with carbon lining approximately 30 in. (76 cm.) thick at the bottom of the crucible and 18 in. (46 cm.) on the sidewalls. The transformer equipment consisted of 3 single-phase Pittsburgh transformers each rated at 667 k.v.a. and connected Δ/Δ. These transformers were provided with taps for 65, 75 and 85 volts and during the test were operated at no-load voltage of 75 volts. Three 24-in. round amorphous-carbon electrodes were used in water-cooled top holders. Motor-operated winches served to move electrodes up and down, but the furnace was not provided with automatic regulators. The furnace was tapped at intervals of about 1½ hr. The slag and metal was allowed to flow into sand pits, where it solidified, and was then removed to the yard, where the slag was separated and metal weighed and loaded into cars.

The furnace charge was varied slightly from time to time during the test but was substantially as follows:

	Lb.		Lb.
Ore	500	Limerock	90
Coal	150	Turnings	30

This charge gave us metal containing 70.9 per cent manganese. The coal is, however, too high and the limerock too low for best results. A method for calculating the charge will be given later on.

Balance Sheet

The furnace was operated on the above charge for a period of 274 hr., during which time a total of 501,000 lb. of the ore mixture was smelted, yielding 186,419 lb. of metal containing 70.9 per cent manganese. The slag from the furnace was kept separate from the slag resulting from other furnace operations and was weighed, sampled and analyzed. The complete balance sheet follows:

	Charge	Products		
Ore, 501,000 lb.		Metal	Slag	Gases
Mn	178,096	132,171	4,482	41,443
Fe	8,831	8,831	.....	.....
Si	31,501	15,286	16,215	.....
Al_2O_3	9,790	.....	8,342	.....
BaO	150	.....	925	.....
MgO	5,753	.....	4,313	.....
CO_2	83,517	.....	.....	83,517
H_2O	57,415	.....	.....	57,415
Comb. Og	115,673	.....	20,588	95,085
Flux, 91,100 lb.				
CaO	50,105	.....	47,162	.....
CO_2	39,355	.....	.....	39,355
Coal, 147,890 lb.				
Fe	1,270	1,270	.....	.....
Si	1,688	.....	659	1,029
Al_2O_3	1,088	.....	.....	.....
MgO	257	.....	.....	.....
C	80,495	9,135	.....	71,360
Volatiles	46,926	.....	.....	46,926
H_2O	11,567	.....	.....	11,567
Iron, 29,796 lb.				
Fe	29,796	19,540	.....	10,256
Totals, 769,786		186,233	102,686	457,953

Metal and slag represent actual analyses.
Only 2.97% unaccounted for by balance sheet.

Analyses of metal and slag were as follows:

Slag	Per Cent	Metal	Per Cent
Mn	4.26	Mn	70.9
SiO_2	34.37	Fe	15.9
Al_2O_3	7.93	Si	8.2
CaO	44.83	C	4.9
MgO	4.10		
BaO	0.88		99.9
	96.37		

Ratio ore to metal	2.68
Per cent total manganese in metal	74.21
Per cent total manganese in slag	2.51
Per cent total manganese in gases	23.28
Per cent of charge accounted for in metal	24.22
Per cent of charge accounted for in slag	13.67
Per cent of charge accounted for in gases	62.11
Pounds slag per ton of metal	1,129
Pounds gas per ton of metal	5,130
Pounds electrode per ton of metal	150
Kilowatt-hours per ton of metal	4,879

Calculation of Theoretical Power Requirement

From our balance sheet it is possible to compute a heat balance of the furnace. In so doing we shall assume:

1. That the slag and metal contain at tapping 600 and 400 calories of heat respectively.

2. That the gases escape from the furnace at temperature of 300 deg. C.

The heat available is principally the heat of oxidation of the carbon plus that furnished by the electrical energy used. The charge gives up to the carbon, as shown by the balance sheet, 95,085 lb. of oxygen. The 71,360 lb. of carbon burned would require 71,360 × (16 ÷ 12) = 95,147 lb. of oxygen to burn to CO or practically all the carbon is burned to CO. Carbon monoxide is capable of reducing manganese dioxide to the monoxide, and it appears probable that a certain amount of reduction takes place in this manner. The balance of the carbon monoxide escapes as such and burns at the top of the charge.

The heat of formation of the slag will be taken as 150 calories per lb. of contained SiO_2 and Al_2O_3. The heat of combustion of carbon with manganese is about 825 calories per lb. of carbon combined, while the heat of formation of manganese silicide is 1,693 calories per lb. of silicon combined.

HEAT AVAILABLE FOR ENTIRE TEST

	Pound Calories
Supplied by electric current	X
Oxidation of C to CO = 71,360 × 2,430	173,404,800
Formation of silicate slag = 44,500 × 150	6,675,000
Formation of Mn_3C = 9,135 × 825	7,536,375
Formation of Mn_7Si_2 = 15,286 × 1,693	25,879,198
Total	X + 213,495,373

HEAT DISTRIBUTION

	Pound Calories
Reduction of Mn from MnO_2 76,656 × 2,278	174,622,368
Reduction of Mn from MnO 96,969 × 1,653	160,289,757
Reduction of Fe from FeO 4,409 × 1,173	5,171,757
Reduction of Fe from Fe_2O_3 5,692 × 1,746	9,938,232
Reduction of Si from SiO_2 15,286 × 7,000	107,002,000
Calcination of $CaCO_3$ and $MnCO_3$ 122,872 × 1,026	126,066,672
Distillation of volatile from coal 46,926 × 800 (assumed)	37,540,800
Expulsion of moisture 68,982 × 600	41,389,200
Sensible heat in gases*	36,003,000
Sensible heat in slag 105,201 × 600	63,120,600
Sensible heat in metal 186,419 × 400	74,567,600
Total heat energy required	835,711,986

Equating heat input and outgo

$$213,495,373 + X = 835,711,986 \text{ lb. cal.}$$
$$X = 622,216,613 \text{ lb. cal.}$$

But 1 Kw.-hr. = 1,897 lb. cal.

hence required electrical energy, no allowance being made for radiation, is 328,000 kw.-hr.

During the test there was produced 93.2 tons of ferromanganese. The theoretically required power is therefore

$$\frac{328,000}{93.2} = 3,520 \text{ kw.-hr.}$$

or, say, 3,500 kw.-hr. per short ton.

PERCENTAGE HEAT DISTRIBUTION

	Per Cent Total Heat Required
Reduction of manganese	40.1
Reduction of iron	1.8
Reduction of silicon	12.8
Calcination of $CaCO_3$ and $MnCO_3$	15.1
Distillation of volatile from coal	4.5
Expulsion of moisture	4.9
Sensible heat in gases	4.3
Sensible heat in slag	7.6
Sensible heat in metal	8.9
	100.0

From the above it would at first appear that considerable saving might be effected by calcining the ore and limerock previous to charging it into the furnace. This assumption, however, does not seem to be borne out in practice. The greater part of the work of calcination is brought about in the upper part of the charge column utilizing heat which would otherwise be lost. Some economy of operation should, however, result and the practicability of the operation should be carefully investigated.

*Sensible heat in gases at 300 deg. C.

	Kilogram Calories
CO, 166,445 lb. = 60,000 cu.m. × 0.311	18,660
CO_2, 122,872 lb. = 28,148 cu.m. × 0.436	12,273
H_2O, 68,982 lb. = 38,630 cu.m. × 0.34	13,134
Vol. from coal, 46,926 lb. = 21,285 cu.m. × 0.311	6,620
Vol. manganese, etc., 42,472 lb. = 4,816 cu.m. × 0.8	3,863
	54,550
54,550 × 300	16,365,000

From the above computation we are enabled to compute the heat efficiency of the furnace tested to have been 71.7 per cent. This figure is very good for a furnace of the size upon which the test was conducted.

The heat loss is due of course in part to radiation of heat from the furnace itself and in part to I^2R losses. A test carried out on a similar furnace showed 40 per cent of the heat loss to be due to radiation and 60 per cent to the I^2R losses. Of this 60 per cent the following distribution may be made:

	Per Cent		Per Cent
Transformers	17.5	Contacts	37.5
Conductors	30.0		
Electrodes	15.0	Total	100.0

The above analysis gives us, I think, a very comprehensive idea of the heat requirements of an electric furnace producing ferromanganese. Due to lack of accurate data certain assumptions had to be made in computing the theoretically required power, but the result obtained is sufficiently accurate for all practical purposes.

Slags

In studying electric furnaces producing ferromanganese my attention was called to the great variety of slags produced. It seemed worth while to investigate the question of slags with the idea in mind of seeing whether or not means could be found to calculate a charge which would give a slag of low manganese content. From a considerable number of samples, eight typical slags were selected and carefully analyzed.

No. 1. A hard gray slag containing ferromanganese inclusions.

No. 2. A medium green hard slag with few, if any, metal inclusions.

No. 3. A dark green hard slag with little in the way of inclusions.

No. 4. A high-lime air-slacking slag.

No. 5. A high-lime air-slacking slag.

No. 6. A light-gray glassy slag.

No. 7. A light-green hard slag.

No. 8. A light pea-green hard slag.

ANALYSES OF SLAG SAMPLES

	1	2	3	4	5	6	7	8
SiO_2	28.2	31.5	26.6	34.4	22.4	30.9	31.9	32.9
FeO	1.2	0.7	1.0	0.1	0.1	1.1	1.3	0.8
Al_2O_3	17.3	8.0	9.6	7.7	6.8	10.0	10.1	8.7
CaO	41.4	35.7	31.1	42.2	46.8	37.8	35.3	36.0
MgO	7.6	1.8	1.1	1.8	4.0	10.2	10.4	2.1
BaO	0.4	1.3	4.8	1.1	0.2	0.2	0.3	1.2
Mn	2.1	14.5	19.9	8.1	5.3	4.7	5.8	12.2
Total	98.2	93.5	94.1	95.4	85.6	94.9	95.1	93.9

It will be noted that in this collection of slags we have two types only as regards their physical condition, *i. e.*, hard slags and air-slacking slags. Air-slacking is due to a composition such that calcium orthosilicate, $2CaO.SiO_2$ separated as one of the phases. The orthosilicate crystallizes in three distinct forms, the alpha-form, stable above 1,410 deg. C. to the melting point, the beta-form, stable between 675 and 1,410 deg., and the gamma-form, stable below 675 deg. C. The transformation of the beta-orthosilicate into the gamma-form is accompanied by a 10 per cent volume increase. It is this volume increase, therefore, that accounts for what I have termed the air-slacking of slags 4 and 5: The presence of much magnesia in the slag tends to prevent this latter transformation.

Manganese occurs in the slags in three ways: first, as ferromanganese inclusions; second, as manganese silicate, and third, as manganates or manganites of calcium or in some cases as oxides of manganese in solution in the slag. Any slag that is insufficiently fluid will contain more or less in the way of ferromanganese inclusions. Lack of sufficient carbon to reduce the manganese will, of course, promote the formation of manganates and manganites. Excess silica seems to tend to form silicates even when sufficient carbon is at hand to reduce all the oxides of manganese to metal.

A green slag is evidence of lack of sufficient carbon to carry out the reduction of the manganese oxide. The depth of color is an indication of the amount of manganese present. When there is an excess of silica present, slags are sometimes pink due to the presence of manganese silicate.

An excess of reducing agent tends to the formation of calcium carbide and graphite accretions in the furnace. This may in some cases be carried so far as to leave an excess of silica and promote the formation of manganese silicates in the slag; in any event, there is a waste of power and the accretions interfere with operations, rendering it necessary to shut down and dig out the furnace at frequent intervals. The best slags seem to have a composition of about 30 per cent silica, 15 per cent alumina and 50 per cent lime plus magnesia, or better, should have an oxygen ratio, alumina being counted as base, of between 1.25 and 1.50. A slag of this composition is easily fusible, separates well from the metal and is economical to make.

Volatilization Losses

Under volatilization in the balance sheet has been included losses by dusting. In the electric furnace losses by dusting should not be large. Some loss by dusting is caused by occasional blows and boils occurring during periods of irregular operation. That the greater part of the manganese lost except for that contained in the slag is volatilized in some manner is very evident. In just what form or forms the manganese is volatilized I do not know nor have I ever seen a satisfactory explanation of the phenomenon. It is usually considered that the manganese is volatilized, as the metal escaping from the furnace burns at the surface of the charge to the oxide. The presence of brownish fumes in the gases escaping from the furnace would readily lead one to this conclusion. On the other hand, I have observed furnaces running with a comparatively cool top when there was no evidence of these brownish fumes but which were still volatilizing a considerable amount of manganese.

In the case of furnace volatilizing considerable amounts of manganese, I have observed that considerable amounts of iron also vanish, in fact, based on the relative proportions of iron and manganese in the charge, more iron than manganese is volatilized.

An attempt to reduce the manganese content of the slag by using more carbon is accompanied in most instances by an increased volatilization loss.

In order that we may learn how to minimize our volatilization losses, it is important that we should know in what manner manganese is volatilized.

Excessive volatilization will occur inevitably in a furnace improperly designed as regards heat distribution. A furnace must be properly proportioned with reference to the power input in order to operate efficiently. Given such a furnace, however, we often find that the volatilization losses vary widely from time to time. The theory has been advanced that manganese and iron are volatil-

ized as carbonyls which in the hot top furnace burn to the oxides of the respective metals and carbon dioxide, and in the case of furnaces operating with a cooler top may pass off unnoticed as gases. This fits in very nicely with my observations with reference to addition of carbon, and its effect on increased volatilization. The formation of carbonyls if such exist may be due to the formation of carbides of iron and manganese which in turn react with the metallic oxides present, reducing them and at the same time setting free carbonyls.

As in many cases the slags produced by the electric manganese furnaces have a distinct fluxing value, it might be well to throw more manganese into slag by cutting the carbon on the charge provided the combined loss in manganese is not increased thereby.

Calculation of Charge

The charge will be calculated on the following basis:

1. We shall assume that the metal is to contain 70 per cent manganese, 5 per cent carbon, 5 per cent silicon and 20 per cent iron.

2. The charge will be calculated on the basis of 100 lb. of ore.

3. In proportioning the amount of reducing agent required, we shall assume that the fixed carbon only is available for bringing about the reduction of the several metals. As has been pointed out, this is not a correct assumption, as some reduction is very evidently effected by the carbon monoxide gases and possibly the volatile hydrocarbons. It gives us, however, a starting point and in the absence of complete data as to the reducing power of the fuel used, enables us to calculate the charge.

4. The magnesia will be calculated to $2MgO.SiO_2$, alumina to $Al_2O_3.3CaO.2SiO_2$, and the balance of the silica to $2CaO.SiO_2$.

5. Sufficient iron will be added to give metal containing 20 per cent iron, assuming 80 per cent of the manganese to enter the metal.

CARBON REQUIREMENT

C to reduce MnO_2 to Mn	$\frac{23.92 \times 24}{87}$ =	6.60
C to reduce MnO to Mn	$\frac{26.37 \times 12}{71}$ =	4.46
C to reduce FeO to Fe	$\frac{1.14 \times 12}{72}$ =	0.19
C to reduce Fe_2O_3 to Fe	$\frac{1.40 \times 36}{160}$ =	0.31
C to reduce SiO_2 to Si	$\frac{4.34 \times 24}{60}$ =	1.73
C to supply metal	=	2.02
		15.31

We shall, therefore, require $\frac{15.31}{0.5443}$ = 28.1 units of coal per 100 units of ore.

In the ore and coal we shall have to flux after allowing for the 4.34 units of silica which is reduced and which enters the metal:

9.82 units	SiO_2	1.24 units	MgO
2.15 units	Al_2O_3	0.03 units	BaO

Now, figuring MgO to $2MgO.SiO_2$, we get

$$\frac{1.24 \times 140}{80} = 2.17 \text{ units } 2MgO.SiO_2$$

Figuring Al_2O_3 to $Al_2O_3.3CaO.2SiO_2$

$$\frac{2.15 \times 388}{102} = 8.18 \text{ units } Al_2O_3.3CaO.2SiO_2$$

Then, 6.31 units of SiO_2 remain to be fluxed.

Calculating to $2CaO.SiO_2$, we have

$$\frac{6.31 \times 172}{60} = 18.1 \text{ units } 2CaO.SiO_2$$

Total lime required = 15.24 units, or marble on charge would be

$$\frac{15.24}{0.55} = 27.7 \text{ lb. per 100 lb. ore}$$

We have in slag

	Theoretical Analysis Per Cent
9.82 units SiO_2	34.4
2.15 units Al_2O_3	7.6
1.24 units MgO	4.4
0.03 units BaO	0.1
15.24 units CaO	53.5
28.48	100.0

Assuming 80 per cent recovery of manganese the iron required would be 6 lb. per 100 lb. ore.

Our charge, based on 500 lb. of ore, would then stand

	Lb.		Lb.
Ore	500	Limerock	140
Coal	140	Turnings	30

If no special attempt is made to keep the silicon down to 5 per cent, the lime can be cut to a considerable extent, depending upon the amount of silicon permissible in the metal. If low silicon metal is desired, the coal may be cut, leaving the limerock as above. The coal may in any event be reduced somewhat, as has been pointed out previously, but this should be done a little at a time and the furnace watched carefully. At least 24 hr. should be allowed to elapse between such changes. The calculation of the charge can at best only serve as a guide. Much depends upon the characteristics of the furnace that is being operated. The operator must watch his furnace and vary the charge to suit operating conditions.

New British Plans for Trade Information

The Overseas Trade Department is now preparing for publication manuals or handbooks of commercial information relating to various countries. These publications, which are intended to be books of reference for British traders, give the stable features of the country described—resources, products, commercial treaties and law, transport, and trading methods. The manuals for France and Argentina are nearly ready, and some material has been accumulated for those on Brazil, Italy, and Greece. They are prepared by the economic and editorial section.

The department is also preparing to issue periodic reports sent in by commercial diplomatic officers on instructions issued last year. These are to take the place of the old consular reports, which were issued periodically from 1858 until the war, but will be a systematic survey of each of the principal countries as a whole. When the organization of the economic and editorial section is complete, it will also be possible to prepare special economic memoranda on topics of outstanding interest which are not otherwise provided, either because of the technical research involved or because of their broad international character. It is hoped that one of the principal categories of such studies will be international commercial finance. At present the section is dealing with reports upon the economic and trade situation in countries severely affected by the war. Sir Hubert Llewellyn Smith called for special reviews of this character, and these are now being brought together so as to form a general survey of European trade conditions at the close of the year 1919.

The German Nitrogen Syndicate*

A Discussion of Germany's Capacity for Nitrogen Fixation Before and After the War, and Her Present Independence—Frank Recognition of the Effect of Foreign Competition—Description of Government Control of Production, Distribution and Prices

BY PROF. N. CARO

ONE of the most far-reaching achievements of the German War Ministry was the development of the nitrogen industry. While Germany before the war was obliged to import something like 100,000 tons of nitrogen a year in order to meet the requirements of her agriculture and industries amounting to 220,000 tons per year, she is now able to meet her greatly increased demands solely from domestic manufacture. Before the war, there was produced in Germany each year:

	Tons Nitrogen
1. In coke ovens, gas plants, and other byproduct installations, about 550,000 tons of ammonium sulphate, equal to	110,000
2. In lime-nitrogen plants about 50,000 tons of lime-nitrogen, equal to	10,000
Total	120,000

The nitrogen plants built during the war for the production of lime-nitrogen and ammonia when completed will be in a position to produce about 380,000 tons of nitrogen per year, so that the total yearly production will amount to over 500,000 tons of nitrogen. This output of nitrogen will be divided thus:

	Tons Nitrogen
Ammonia, by the Haber process	300,000
Ammonia from coke ovens, gas plants, and other by-product installations	110,000
Lime-nitrogen	100,000
Total	510,000

The government took an active part in the increase in nitrogen production secured during the war. It owns the Imperial Lime Nitrogen Plants in Piesteritz and Chorzow, which have a yearly output of about 60,000 tons of nitrogen. It took part in the extension of the plants of the Badische Anilin und Soda Fabrik at Oppau, the lime-nitrogen plants in Waldshut (the Lonza Works), at Knapsack (Aktiengesellschaft für Stickstoffdünger) and Margarethenberg (the Bayerischen Stickstoff Works).

The views of the parties concerned as to whether German agriculture will be in a position to absorb these great quantities of nitrogen are at variance. It is generally agreed that it will be possible to apply to German farms and fields triple the amount of nitrogen which they now receive and so to increase their yields that the importation of foreign food and foodstuffs will be unnecessary or at least limited to particularly high-value products, for it is generally assumed that in most cases this increased nitrogen application still lies below the limits of maximum action. Therefore with a complete fertilization one should count on an increase in yields of about 20 to 25 kg. vegetables (15 kg. straw), or 125 kg. potatoes, or about 150 kg. sugar beets, or 250 kg. fodder beets, per kilogram of applied nitrogen. It is not agreed as to whether the natural limitations of agriculture, the physical peculiarities of the soil, the water supply, the equipment, the efficiency of agricultural labor, will allow the increased production which would be expected from this increased application of nitrogen, for all of these factors either have undergone great depreciation during the war or have been wholly destroyed. In this difference of opinion the decision is of importance as to the beneficial action of nitrogen on the soil when there is a simultaneous impoverishment of phosphoric acid and as to whether there really is any phosphate impoverishment or not.

PRE-WAR FERTILIZER SITUATION AND PRESENT OUTLOOK

Before the war 200,000 tons of nitrogen and 600,000 tons of phosphoric acid were used each year, that is, one part of nitrogen was used to every three parts of phosphoric acid. It is frequently assumed that this relation must be adhered to in order to assure a continuous full fertility of the soil, because the phosphoric acid is utilized only to the extent of about 30 per cent. On the other hand, it is assumed by many of the authorities on this subject and by practical farmers that this ratio can be altered to about one part of nitrogen for every part of phosphoric acid without diminishing the activity of the nitrogen, since great quantities of phosphoric acid have been previously added to the soil and have not yet been used up. The resulting accumulation of phosphoric acid, in conjunction with the increased application of nitrogen and with other improvement of the soil, depending on circumstances, by means of gravel, lime or clay, should make possible a considerably increased utilization of the phosphoric acid. It should be remembered in this connection that plant material on the average contains only one part of phosphoric acid to two parts of nitrogen, so that if phosphoric acid were applied even in this ratio no impoverishment of the soil in the strict sense would occur.

In this conflict of opinion one thing can be taken as certain—namely, that under given conditions in the next few years very much greater quantities of nitrogen than before the war can be supplied with full effect, even if the possible maximum does not hold.

The situation as regards prices will be of the very greatest importance for the utilization of this increased amount of nitrogen; in the first place, because the cost of fertilizers in general, as a result of the inevitable increase in cost of phosphoric acid, will be greater than before the war; and also in view of foreign competition.

IMPORTANCE OF FOREIGN COMPETITION

In fixing nitrogen by the Haber process coal, and by the Frank-Caro process coke, is required. The price of coke has advanced since the upheaval of the war by about 60, that of coal by about 50, and that of brown coal

*Translation from *Chemische Industrie*, Nos. 13 and 14, July, 1919, by Arthur B. Lamb.

by 9½ marks per ton. Wages, in spite of their already extreme high level, are still tending to rise.

How far the German nitrogen industry will be able to cope with foreign competition, in view of these high wages and high costs of combustibles, cannot at present be predicted. Since the cost of coal, which in the future is sure to be one of the most important items of expense, can hardly decrease, the lime-nitrogen industry, on account of its unusually small consumption of coke, will be in a very favorable situation. This will be particularly true when the construction market sinks to some halfway normal level so that the capital cost of water-power developments will be more reasonable. On the other hand, if this rise in the cost of coal continues, those lime-nitrogen plants which depend on steam power will surely be forced to transfer their carbide furnaces to places where water power is available.

Saltpeter, in addition to lime-nitrogen, is of considerable significance as regards foreign competition in fixed nitrogen. How far Chilean saltpeter can meet a reduction in price, and therefore come again into use here, depends largely on the price of coal and the level of wages in Germany. One should not overlook the fact that extensive improvements and economies in operation are possible in the Chilean saltpeter industry and that the development of the fixed-nitrogen industries in other lands will surely force the Chilean producers to undertake these improvements. Certainly the high freight rates and the small exchange value of the German mark outside of Germany will prevent the importation of saltpeter into Germany; but how long these circumstances will persist it is difficult to predict with certainty. Anyway, we must expect that if any further rise in the cost of coal or the level of wages in Germany occurs, competition with Chilean saltpeter is not out of the question.

Far more dangerous, however, at the present time, appears to be the possibility of competition with artificially fixed nitrogenous fertilizers produced in foreign countries.

American Competition

The fixed-nitrogen industry has undergone an extensive development in many foreign countries, chiefly through the construction of new lime-nitrogen plants. Almost without exception these plants are situated near sources of very cheap water power or of natural gas, and are therefore but slightly affected by the increase in cost of combustibles.

The largest of these plants is located in the United States, in Alabama. Its situation is most excellent. It is connected with the ocean by means of the Coosa River,[1] which has been made navigable. It is situated at a source of almost constant water power amounting to 400,000 horsepower, and is right in the midst of a locality where all the raw materials of the lime-nitrogen industry are present in the highest purity and at the very lowest prices. From the extensive deposits of bituminous coal the very best coke can be obtained, which cost during the war only about 75c. per ton.[2] For burning the very pure marble limestone, the otherwise unutilized gases from the coke ovens are available. Great quantities of copper-bearing pyrites furnish, on smelting, sulphur dioxide, which must be converted into sulphuric acid, but which at the present time is not used on the spot. Near by are inexhaustible deposits of high per cent phosphate rock. The possibility therefore exists of using the otherwise wasted sulphuric acid and phosphate to make phosphoric acid, and by neutralizing this with ammonia from lime-nitrogen, producing cheaply the so-called American "ammophos," or ammonium phosphate, containing roughly 45 per cent of water-soluble phosphoric acid and 20 per cent of nitrogen.

To be sure, the United States is in a position to use right there the nitrogen thus produced, amounting to about 130,000 tons per year; particularly as the plants are located in the midst of an extensive cotton-growing district. Nevertheless, a considerable extension of this project is contemplated and because of the high intrinsic value of the product (ammonium phosphate) it will be possible to ship it to long distances to places where its phosphoric acid content will be of importance, and hence it will be sure to offer very strong competition to the German fixed nitrogen industry.

Norwegian and Other Competitions

The economy with which nitrogen can be produced in the Norwegian lime-nitrogen plants is of a similar order, but the situation is perhaps not quite so favorable as in the above case. According to recent information the yearly production of these plants is between 100,000 and 130,000 tons of nitrogen. They, too, are located near cheap water power, and since they can utilize their product as return freight in ships bearing English coke, they are in a position to operate cheaply and to ship their output to great distances.

Published figures from other countries show that their output from lime-nitrogen per year is as follows:

	Tons Nitrogen		Tons Nitrogen
France	30,000	Bohemia	7,000
Spain	10,000	Lower Rhine	7,000
Italy	30,000	Japan	48,000
Dalmatia	24,000	Canada	40,000

So, as far as is known, about 450,000 tons of nitrogen can be produced as lime-nitrogen every year in foreign countries, while a further output of 500,000 tons per year will be provided by great plants already under construction. Moreover, the very great increase in the amount of ammonia secured in byproduct coke ovens in all countries where coal and coke are produced, particularly in the United States and in England, must be taken into consideration, so that an increase in the yearly output of fixed nitrogen from foreign countries amounting to 500,000 tons must be assumed.

Economic Outlook of the Nitrogen Industry

The total increase, then, in the yearly output of nitrogen in Germany and all foreign countries amounts to about 800,000 tons and is considerably greater than corresponds to the total output of Chilean saltpeter before the war (3,500,000 tons). This will surely affect the nitrogen market very decidedly, even if we can count with certainty on a very great increase of the nitrogen consumption in all countries. The competition of foreign countries is of even more consequence in considering the future German situation, when it is recalled that even in the year 1914, before the war, a combination of the saltpeter and lime-nitrogen producers of the whole world was proposed.

We can be very sure that faced by such circumstances the German industry will have no easy task in furnish-

[1] The author is in error regarding the location. The plant is at Muscle Shoals, on the Tennessee River.—Editor.

[2] This figure is evidently a mistake. As reported during the hearing before the House Committee on Military Affairs (Chem. & Met. Eng., vol. 21, No. 2, July 15, 1919, p. 67), the cost of coke at U. S. Nitrate Plant No. 2 was $6 per ton.—Editor.

ing an adequate supply of this material to German agriculture at *cheap* prices. The government, therefore, as soon as it had begun to take an interest in the nitrogen situation, was busied with arrangements to consolidate the German nitrogen industry, so that it might fulfill its function satisfactorily and be resistant to outside attack.

Establishment of the Nitrogen Traffic Monopoly

For this purpose in 1915 the government brought forward legislation permitting the establishment of a nitrogen traffic monopoly. The purpose of this proposal as appeared from the discussion was not so much the introduction of a traffic monopoly itself as the establishment of a close organization of the industry and the assurance to agriculture of suitable, and, indeed, extremely cheap prices for nitrogen (namely, 70 pfennigs per kilogram of nitrogen in lime-nitrogen). The proposal was not rejected, but also it was not adopted. It remained unacted on in the Commission.

Meanwhile, a further increase in the nitrogen industry of about 200,000 tons per year has taken place. The whole situation has altered and the production costs of all the processes have undergone a complete re-alignment. Certain efforts by the government have resulted in the establishment of an autonomous combination within the industry. On May 8, after the Finance Commission of the National Assembly had granted permission, the Nitrogen Syndicate, in co-operation with the government, was established as a limited company (Gesellschaft mit beschrankter Haftung) which included the whole nitrogen-producing industry, as well as other industries related to it. The incorporators of this undertaking, which has a nominal capital of 241,800 marks, are as follows:

	Shares in Marks
1. Badische Anilin und Soda Fabrik	150,000
2. The lime-nitrogen firms	41,800
3. The German Ammonia Sales Co., together with its affiliated organizations of the Oberschlesian Coke Works and the Union of German Gas Works	50,000
Total capital	241,800

The allotment of production is as follows:

	Tons Nitrogen
1. The Badische Anilin und Soda Fabrik up to	300,000
2. The lime-nitrogen industry up to	93,000
3. The byproduct industries up to	120,000
Total	513,000

The government, and each of the three incorporations, have the right to name one member of the four-membered board of directors.

The government has retained for itself the far-reaching right for the conduct of the business, and particularly for the allocation of the product, and the fixing of prices. The board of managers of the company is to consist of ten persons, who will be intrusted with most of the control of the business. The government, the Badische Anilin und Soda Fabrik and the byproducts industries will elect three members each of this board, and the lime-nitrogen industry one member. Each group will further appoint alternates equal in number to its members. The chairman of the board, as the foremost director of the business, will be selected by the government, and the vice-chairman from the three members named by the Badische Anilin und Soda Fabrik. The function of the board of directors is an honorary one. The chairman, as business director, only will be paid. Decision as to sales, prices, etc., will require approval of the government representative. As a fundamental basis, the price of nitrogen in lime-nitrogen, ammonium sulphate and saltpeter has been fixed in ratio of 8 : 9 : 10.

The sale of the output depending on the demand will take place according to the deserts of the single products. Every output will be computed on its own basis and all the plants will receive for every product the prevailing average price. Exportation can take place only after all domestic demands have been met.

How the distribution will be carried through in detail has not yet been decided, but it will be carried out on a basis of the already existing organizations of agriculture and of legitimate trade. For this purpose, at the instigation of the Finance Ministry, a joint body consisting of the producers and consumers was established, called its Nitrogen Commission, to which the determination of the prices, conditions of delivery, etc., were intrusted. The Commission consists of twenty-two members. The Nitrogen Syndicate, the government and agriculture name five each, the fertilizer manufacturers and the fertilizer dealers each elect one. Three members are appointed by the Associated States and one each by the Labor Bureaus of Industry and Agriculture.

Future Developments of the Organization a Matter of Conjecture

The organization thus fixed upon gives each of the industries concerned and any new industries the possibility of far-reaching development, and on the other hand, at the same time permits the government, by the control of all distribution, exportation and prices, to safeguard the social and financial interests intrusted to it, as had been demanded by the National Assembly. It makes possible the distribution of nitrogen in a more rational manner than has previously been the case, since, by a centralized control of distribution, transportation and storage facilities are utilized in the most efficient manner possible.

By the establishment of the Nitrogen Snydicate and of the Nitrogen Commission an important step has been taken to assure the success of the German chemical and agricultural industries. How far the Nitrogen Syndicate can also be looked upon as a money-making enterprise will depend on future developments, particularly on how large production costs will prove to be. The government takes a leading part in this production and therefore is in a position to judge regarding all the factors which come into play and to influence them. For the present it will maintain the existing standards of maximum prices and assessments (in agreement with the requirements of the National Food Ministry of March 13, 1919) until a clearer insight can be had into production and importation situations.

Exposition of United States Manufacturers in Buenos Aires

Twenty-two countries are holding foreign trade fairs during 1920, and of these France schedules eight, Germany twelve, Great Britain nine and Italy four. Among others of interest to manufacturers in the United States is the National Exposition of U. S. Manufacturers to be held at Buenos Aires in October. It is to be arranged and managed by the American National Exposition, Inc., of New York, G. Hough Perry, director.

Classification and Salaries for Chemists

Report of the Congressional Commission on Reclassification of Government Salaries, Outlining the Qualifications, Principal Lines of Promotion and Compensations for Government-Employed Chemists

BY R. S. McBRIDE

THE report of the Congressional Commission on Reclassification of Government Salaries, presented recently, gives us the first systematic classification which has ever been made in the varieties and grades of technical positions which are encountered in our complicated professional life. This classification has a very large interest to executives and employing chemists, for it gives a clean-cut basis upon which they can judge the relative responsibility which should be intrusted to men of different grades in technical and scientific work. The relative responsibility for planning and execution of research and for the conduct of executive work in a chemical organization is particularly important, as in many cases there is very little understanding of the degree of experience really required for executive work in different places.

The classification of chemists which is proposed divides workers in this science into two major groups—those in the sub-professional grades, who are called junior aid or senior aid in chemistry, and the group which includes those who are graduated from a collegiate course specializing in chemistry, who are called junior chemist, assistant chemist, associate chemist, chemist, or senior chemist, according to the exent of their experience. A very similar classification using the same titles and the same general qualifications and duties was adopted by the commission for all the other engineering and scientific services of the Government. In other words, the commission has recognized the same principles to govern in all of these professional fields. The definite statements of the commission with respect to these various classes in chemistry are as follows:

JUNIOR AID IN CHEMISTRY

Duties: To assist chemists in the performance of routine laboratory work; and to perform related work as required.

Qualifications: Training equivalent to that represented by graduation from high school, including one year of chemistry and one year of physics; accuracy and carefulness.

Principal Lines of Promotion: To, senior aid in chemistry.

Compensation for Class: $840-$900-$960-$1,020-$1,080-$1,140-$1,200 per year.

SENIOR AID IN CHEMISTRY

Duties: To assist chemists in the performance of chemical work, or to make routine chemical analyses; and to perform related work as required.

Qualifications: Training equivalent to that represented by graduation from high school, and by not less than two years' college work, including at least fifteen college credits in chemistry; accuracy and carefulness.

Principal Lines of Promotion: From, junior aid in chemistry. To, junior chemist, junior metallurgist.

Compensation for Class: $1,200-$1,320-$1,440-$1,560-$1,680-$1,800 per year.

JUNIOR CHEMIST

Duties: To perform, under immediate supervision, routine work in chemistry; and to perform related work as required.

Qualifications: Training equivalent to that represented by graduation with a degree from an institution of recognized standing, with major work in chemistry, including general inorganic, analytical, and organic chemistry; additional training in one or more of the following optional lines; biological, dairy, engineering, explosives, food, fuel, inorganic, metallurgical, organic, petroleum, pharmaceutical, physical, or soil chemistry; ability to read scientific French or German; and initiative.

Principal Lines of Promotion: From, senior aid in chemistry. To, assistant chemist.

Compensation for Class: $1,800-$1,920-$2,040,-$2,160 per year.

ASSISTANT CHEMIST

Duties: To perform, under supervision, either individually or with the assistance of subordinates, general work in chemistry; and to perform related work as required.

Qualifications: Training equivalent to that represented by graduation with a degree from an institution of recognized standing, with major work in chemistry, including general inorganic, analytical, and organic chemistry, and by not less than two years' graduate work in one or more of the following optional lines: Agricultural, analytical, biological, dairy, engineering, explosives, food, fuel, inorganic, metallurgical, organic, petroleum, pharmaceutical, physical, or soil chemistry; ability to read scientific French and German, and to prepare chemical manuscripts in clear and concise English; and initiative.

Principal Lines of Promotion: From, junior chemist. To, associate chemist.

Compensation for Class: $2,400-$2,520-$2,640-$2,760-$2,880-$3,000 per year.

ASSOCIATE CHEMIST

Duties: To perform, under general direction, either individually or with associates or subordinates, specialized work in chemistry which may or may not involve supervisory duties; and to perform related work as required.

Qualifications: Training equivalent to that represented by graduation with a degree from an institution of recognized standing, with major work in chemistry,

including general inorganic, analytical and organic chemistry, by not less than three years' graduate work, and by one year's professional experience, in one or more of the following optional lines: Agricultural, analytical, biological, dairy, engineering, explosives, food, fuel, inorganic, metallurgical, organic, petroleum, pharmaceutical, physical, or soil chemistry; ability to read scientific French and German, and to prepare for publication, in clear and concise English, manuscripts embodying the results of chemical investigations; and proved technical and scientific proficiency.

Principal Lines of Promotion: From, assistant chemist. To, chemist.

Compensation for Class: $3,240-$3,360-$3,480-$3,600-$3,720-$3,840 per year.

Chemist

Duties: To perform one or more of the following functions: (1) to carry on, either individually or with associates or subordinates, highly specialized lines of chemical research; (2) to act in a consulting or advisory capacity on problems in chemistry; (3) to plan and execute major lines of chemical work; or (4) to perform major administrative work under executive director; and to perform other related work.

Qualifications: Training equivalent to that represented by graduation with a degree from an institution of recognized standing, with major work in chemistry, by not less than three years' graduate work in chemistry, and by not less than four years' professional experience, of which at least three years shall have been in work of the grade required of an associate chemist; proven ability to carry on or to direct research work in chemistry; ability to read scientific French and German, and to prepare for publication in clear and concise English, manuscripts embodying the results of chemical investigations.

Principal Lines of Promotion: From, associate chemist. To, senior chemist; assistant chief, Bureau of Chemistry; chief, Bureau of Chemistry.

Compensation for Class: $4,140-$4,320-$4,500-$4,680-$4,860-$5,040 per year.

Senior Chemist

Duties: To perform one or more of the following functions: (1) to carry on or direct the most difficult and comprehensive lines of advanced chemical investigations; (2) to act as consulting specialist in the field of chemistry; or (3) to perform major administrative work involving the broadest lines of policy; and to perform other related work.

Qualifications: Training equivalent to that represented by graduation with a degree from an institution of recognized standing, with major work in chemistry, by not less than three years' graduate work in chemistry, and by not less than eight years' professional experience, of which at least three years shall have been in work of the grade of chemist; large capacity and proved ability to perform, direct, or administer work in the most difficult and comprehensive lines of chemistry.

Principal Lines of Promotion: From, chemist. To, assistant chief, Bureau of Chemistry; chief, Bureau of Chemistry.

Compensation for Class: (Not specified).

Assistant Chief, Bureau of Chemistry

Duties: To assist the chief in the administration of the work of the Bureau of Chemistry, including the supervision of its field force, inspectional, and clerical personnel, and in the enforcement of the food and drugs act; to act as chief in his absence; or, to assist the chief in the administration of the research work, scientific personnel, and related work of the Bureau of Chemistry; and to perform other related work.

Qualifications: Either (1) training equivalent to that represented by graduation with a degree from an institution of recognized standing; preferably professional legal training in addition; extended executive experience; not less than five years' experience in the administration of the food and drugs act; judicial temperament and exceptional executive capacity; or (2) training equivalent to that represented by graduation with a degree from an institution of recognized standing, with major work in chemistry and related subjects, and by not less than three years' graduate work in chemistry; extended experience in conducting and administering research work in chemistry; large capacity and good judgment of men.

Principal Lines of Promotion: From, chief of district; senior chemist; chemist. To, chief, Bureau of Chemistry.

Chief, Bureau of Chemistry

Duties: Under the general direction of the Secretary of Agriculture, to have administrative charge of all the activities of the Bureau of Chemistry; to be responsible for its expenditures and the efficiency of its employees; to administer the work required in the enforcement of the food and drugs act; to initiate and direct research in agricultural, food, drug, and industrial chemistry, as well as in the field of pure chemis-

SALARIES RECOMMENDED FOR CHEMISTS AND ENGINEERS

	Qualifications for Chemists	Salaries Recommended by Chemists Committee	Salaries Recommended by Engineering Council Committee (for Engs.)	Salaries for Chemists and Engineers Recommended by Classification Commission
Junior aid	High school graduate	$1,200-1,560	$1,080-1,560	$ 840-1,200
Senior aid	Two years' college work	1,680-2,400	1,680-2,400	1,200-1,800
Junior chemist	College graduate major in chemistry	1,800-2,760	1,620-2,580	1,800-2,160
Assistant chemist	Two years' post-graduate work *	3,000-3,960	2,700-4,140	2,400-3,000
Associate chemist	Three years' post-graduate *, and one year's professional experience	4,320-5,760	4,320-5,760	3,240-3,840
Chemist	Three years' post-graduate work *, and four years' professional experience, of which three years must be in responsible position	6,000-9,000	5,940-7,860	4,140-5,040
Senior chemist	Three years' post-graduate work *, and eight years' professional experience, of which three years must be in work of chemist grade	10,000-25,000	8,100 and up	No recommendation

* One and one-half years' practical experience judged equivalent of one year of post-graduate work.

try; to consider, and take action on questions concerning chemistry and related subjects referred by the Secretary; and to perform other related work.

Qualifications: Training equivalent to that represented by graduation with a degree from an institution of recognized standing, with major work in science, and by not less than three years' graduate work in chemistry; extended experience in the application of scientific methods of research to the solution of problems in chemistry and related subjects; not less than five years' responsible administrative experience; ability to determine productive lines of research relating to chemistry, and to organize and direct staffs of investigators and regulatory workers.

Principal Lines of Promotion: From, assistant chief, Bureau of Chemistry; senior chemist; chemist.

Experience Required

It should be noted in this series of statements regarding qualifications that emphasis has been laid by the commission upon post-graduate experience in college work. This conclusion is in accordance with the recommendation which was made to it by the committee of chemists of the Government service selected to advise the commission regarding the needs in this field. This committee urged that a distinction be made between the scientific and the technical services in this particular. An engineer typically gains his advanced work in practical, field or plant experience and he advances most rapidly in his profession under these circumstances, in the opinion of those who were advising the commission. On the other hand, the chemist who goes into some laboratory or plant without the broadening influence of post-graduate work is apt to become highly specialized, or narrow in his conception of research and development methods. It is believed, therefore, that post-graduate training is more valuable for a chemist than a corresponding length of time in practical work. However, it was recognized by this committee of chemists, and so recommended to the commission, that three years of practical experience be regarded as equivalent to two years of post-graduate college work. This relationship should be borne in mind when contrasting the qualifications specified for chemists and for engineers.

Salary Recommendations

The Classification Commission had to guide it a large amount of information which had been gathered by the experts sent out to interview persons in the industries, representing altogether in this field many hundred positions for which data were available. The commission also had the report of the committee on classification and compensation of engineers, presented by the representatives of Engineering Council. To supplement these, the committee of Government chemists appointed to advise the commission regarding the chemical services drafted certain recommendations, discussed these in various ways with the chemists within and without the Government service and formulated certain recommendations as to salary schedules. These various recommendations are tabulated and charted to show the contrast.

It will be noted that the recommendations of the chemists are much higher than those which were recommended by Engineering Council's committee. However, there was considerable justification for this, since the data gathered by the chemical investigators of the commission showed that chemists were in general receiving materially higher salaries than engineers of corresponding experience. In explanation of this rather surprising statement, it should be borne in mind that the demand for chemists has increased very rapidly during recent years and the supply has probably not correspondingly increased. It has been inevitable, therefore, that chemical salaries should advance more rapidly than salaries in the engineering field, probably more nearly keeping pace with the increasing costs of living than the salaries of most any other group of technical or scientific workers.

In making the recommendations to the commission regarding salary, the chemists did not anticipate that the salaries recommended could actually be granted immediately, but despite this fact they felt it necessary to set forth a schedule of salaries which could be considered reasonably adequate to meet the competition of the industries for the services of chemists well trained in various fields. In the judgment of this committee, the schedule suggested represents the compensation which any employer of chemists must pay at the

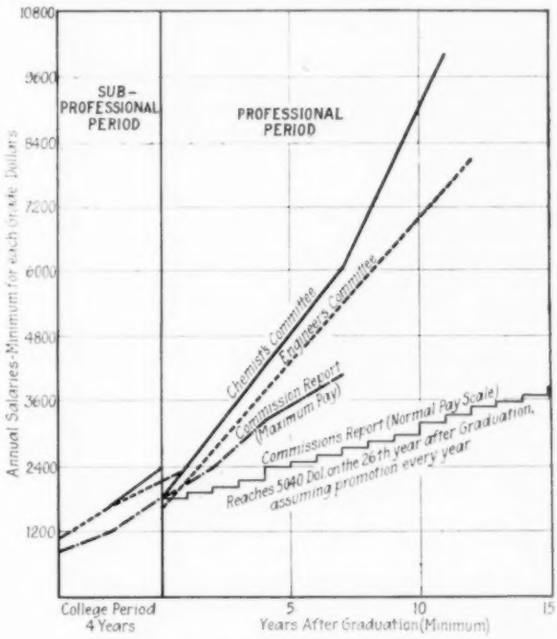

CHART SHOWING SALARIES OF GOVERNMENT CHEMISTS

present time if he is to secure the services of men equal to or above average ability in the different grades. Undoubtedly, many men can be secured at lower rates, but the qualifications or ability would, it is believed, be correspondingly less.

Initial Salary for Government-Employed Junior Chemists as an Inducement for Beginners

In reference to the salary schedule recommended by the committee of chemists, another point should be mentioned, namely, the beginning salary for junior chemists, which was fixed at $1,800, both in the recommendations to the commission and in the commission's recommendations to Congress. This is recognized by all concerned as being a figure slightly above that usually paid in the industries for men just graduated from college in chemical courses. It was believed by the committee that $1,500 per annum would represent more

nearly the beginning salary in industrial work of this sort, but a man going into the industries is usually advanced very rapidly, generally once or twice within the first year of service, if he is really making good. In the Government service such rapid advance is not at all feasible and therefore, in order to attract some of the best available talent from the young graduates, an initial salary slightly greater than that paid by the industries is found essential. Even with this slightly greater starting salary, it is believed that the men in the industries will within a year or two be receiving substantially as much or perhaps a trifle more than those in the Government service, even if the committee's recommendations were adopted.

Promotions

One of the difficult problems in any scientific organization is the question of how often the younger members of the staff should be promoted. In the judgment of the commission, and according to its recommendations to Congress, members of the Government scientific services should be promoted more or less automatically every year, if they are satisfactorily filling their positions. However, these promotions would continue only within the salary range of a single class. For example, a man might be advanced from the initial salary of $1,800 proposed for junior chemists by $120 a year under normal circumstances for three successive years, thus reaching $2,160 per year even though he was just an ordinarily successful man in this grade. To advance from the highest salary in the junior chemists' grade to the lowest salary in the assistant chemists' grade, however, would require a special action of some sort, since it is deemed to be not a normal increase in salary to go from a position of one title to a position of higher title.

It is realized, of course, that these automatic promotions are not sufficient for special cases of unusual merit or ability. Therefore it is anticipated that double promotions would be given to some of the better men and that some men who really were not making good, but who were sufficiently valuable to make it unnecessary to discharge them, would probably not be given any advances at all, even within the grade. However, the thought seems to have been throughout that a normal increase of the size indicated would come more or less regularly each year to most of those within that grade.

General Status

The bulk of the commission's salary material and much of the data presented to them by various agencies has not yet been made public, but will undoubtedly be brought out in the course of any action which the Congressional committees may take upon this report.

In general, the report of the Classification Commission has been very favorably received by the scientific and technical people of Washington, who think the system of classification proposed is excellent and that the general provisions are quite satisfactory. However, the salary schedules recommended for the middle and upper grades are very frequently criticized as being wholly inadequate to hold the technical men required for proper development of the Government service. It is to be expected, therefore, that considerable debate on these points will be developed during any further Congressional action.

Low-Temperature Carbonization of Coal in England

THE coal output of the United Kingdom in 1913 was estimated at 280,000,000 tons, valued at $973,300,000. Between 40,000,000 and 50,000,000 tons is devoted to domestic consumption, and if this amount were converted into smokeless fuel by low-temperature carbonization, some 640,000,000 gal. of fuel oil would be obtained annually. If this system were applied to all coal consumed in the United Kingdom, the quantity of by-products recorded would be enormous.

A recently organized British company is manufacturing a smokeless fuel known as coalite, which is claimed to be a natural briquet, generating as much heat per unit as coal. The volatile constituents of the coal are collected by a process of low-temperature carbonization, recent experiments establishing the following products obtained at one time from one ton of bituminous coal:

(*a*) Three gallons of motor spirit—nearly double the usual yield of motor spirit from processes where coal is distilled at a high temperature. This spirit is refined, and suitable for motor cars, aëro engines, tractors, and every purpose for which petrol (gasoline) or benzol is used today.

(*b*) Sixteen gallons of oils for burning, lighting, and lubricating. This oil is similar to crude petroleum. It can be burned without refining, direct under boilers for naval and maritime purposes generally. If distilled the products obtained are even more valuable and find a ready market for many purposes. The crude oil may be separated into motor spirit, cresylic oils, burning oils for lamps, lubricating oils, oils for Diesel engines, and pitch of superior quality for insulating and other purposes.

(*c*) Seven thousand cubic feet of gas. This gas is of higher quality than that made by gas works and is of great value for lighting, heating, and power purposes. Its heat value is 600 B.t.u. per cubic foot, after removal of the light oils, whereas that of ordinary coal gas, similarly treated, is about 500 B.t.u.

(*d*) Twenty pounds of sulphate of ammonia, for fertilizers and high explosives.

(*e*) Fourteen hundredweight of smokeless fuel.

The question of coal reserves and consumption is receiving a great deal of attention and is bound up with such problems as the generation of electricity by central power stations where coal can be economically consumed with due reference to the salvage of valuable by-products, as well as the provision of smokeless fuel for household use, the provision of motor spirit capable of replacing gasoline, and the supply of fuel oil for naval and mercantile use.

At a recent meeting of the British Association for the Advancement of Science, Sir Dugald Clark stated that if the average figure of 5 lb. of coal per horsepower be reduced to 1½ lb. or less, the industrial civilization of the United Kingdom would be prolonged from 500 to 1,000 years. At the 1913 rate of consumption the coal reserves of the United Kingdom will be exhausted in 500 years, and there is every prospect of increased consumption unless more economical measures are adopted. Therefore as a matter of national economy and conservation of natural resources the burning of bituminous coal in open hearths and furnaces is being deprecated for extravagance no less than in abatement of the dirt, dust, and smoke nuisance.

Peat as a Possible Source of Industrial Power*

Extent and Formation of Peat Deposits—Mechanical Preparation of the Peat Previous to Its Use as Fuel for Steam Raising or in a Gas Producer and the Economic Factors Involved in Its Competing With Coal—Peat as a Source of Ammonia Fertilizer

By HERBERT PHILIPP

THE use of peat as a source of heat goes back beyond the historical period into the ancient history of the early tribes in northern Germany. Pliny, the Roman naturalist, gives us possibly the first indication of the use of peat. He reports that the Teutons on the border of the North Sea dried and burned mud, what we now would call peat. In Ireland, Great Britain, Russia, Scandinavia, Germany, Holland and parts of France peat has been used as a fuel since time immemorial. The peat was cut from the bog very much in the same manner as it is still being done in many parts of Europe, where it is cut in brick shapes, allowed to dry in the wind and sun and stacked up, similarly as the American farmer piles his cord wood.

It is only in the last seventy years that any progress has developed in this industry, and although very little has been done in this country to obtain efficient results in using peat as a source of power, much can be expected in the near future of making this resource valuable and an economic factor in our industrial life.

Extent and Formation of Peat Deposits

Peat is disintegrated vegetable matter accumulated in areas of poor drainage where the chemical decomposition has been partly retarded according to a variety of conditions. Some of the conditions have resulted in complete decay, so that the original substances have disappeared, while others have simply resulted in the loss of more easily changed compounds and gaseous elements, the material retaining its original form and mechanical structure. The deposits of peat are not uniformly distributed over our country, but occur in practically every state east of the Dakotas and north of the Carolinas to the Canadian border. This is supplemented by deposits all along the Atlantic coast, the state of Florida and across Texas to the Mexican border. In the Pacific coast states are some areas of peat deposits, especially in California and in the valleys of some of the lakes and rivers of Oregon and Washington. It is estimated that there are approximately 12,000 square miles of peat deposits in the United States of an average depth of 9 ft. which would represent a total of about 14,000,000,000 tons of fuel, provided the whole were converted into peat fuel, which is no small resource and represents a possible means of furnishing heat and power for a considerable number of years.

It is only in recent years that peat has become of enough interest in this country to endeavor to classify the various kinds which are made. This work is being undertaken by Dr. Alfred P. Dachnowski of the U. S. Bureau of Plant Industry, and his initial attempt represents an admirable contribution to our peat literature. The terms muck, humus, moor, marsh (fen), bog, heath and swamp are terms used without any definite relation to the stage of development of the peat in the deposit. These terms usually relate to the marked physiognomy of vegetation appearing on the deposit. A peat deposit can be defined as a compact accumulation of plant remains of at least 8 to 10 in. (20 to 25 cm.) in thickness. No deposit containing more than 40 per cent of mineral matter must be included in this definition. Peat deposits usually occur upon gentle slopes, flat areas, in shallow depressions on the earth's surface which have neither drainage or are poorly drained so that the surface is always wet or covered by water.

Owing to the various conditions under which peat deposits have been formed and to the various types of vegetable matter composing them and also to the various locations and climatic changes to which they have been exposed, each deposit is practically a study in itself. There are possibly no two deposits that are exactly alike, although a large number may be very similar in composition. This explains one of the reasons why difficulties have been met with in trying to work one deposit by means adapted on another deposit. Even great variations can be noted in deposits which are only a few miles separated.

Growth of Peat Industry

A peat industry exists in this country, and has grown steadily the last twelve years till it now represents a real industry. However, only a small quantity of peat up to the present time has been manufactured for fuel purposes, the largest amounts being used in agriculture and in the fertilizer industry. The statistics in the table show the amount of peat produced and also the quantity used for fuel purposes.

CRUDE AIR-DRIED PEAT AND PEAT FUEL PRODUCED IN THE UNITED STATES, 1908-1918

Year	Total Peat Produced Short Tons	Total Peat Fuel Used Short Tons
1908	24,800	900
1909	29,167	1,145
1910	37,024	.....
1911	55,143	300
1912	47,093	1,300
1913	33,260	.....
1914	47,093	1,925
1915	42,284	.....
1916	52,506	.....
1917	97,363	.....
1918	151,521	20,567

It will be noted that during the last few years the production of peat has practically trebled due to the extensive application of this material in fertilizers. It will be well to mention here that peat in this country is generally comparatively rich in nitrogen, and that is the reason why the use of peat in agriculture is proportionately greater in the United States. The peat fuel production was negligible until 1918, when the high price of coal gave quite an impetus to this indus-

*Read before the New York Section of the American Electrochemical Society, Feb. 27, 1920.

try, and the future offers very promising developments for a successful peat fuel industry in this country.

In Europe practically all the peat which is excavated is used for fuel purposes. Since coal has become high in price and as far as we can determine will remain so, peat becomes an economic factor in our future industrial progress.

Many Failures to Produce Peat Economically

A large number of attempts have been made in the past to produce peat fuel economically, but the majority have proved uncommercial and we cannot speak of any successful peat fuel undertakings before 1918. The large number of failures were due to many factors, which were, chiefly, lack of capital, poor engineering, difficulties of distribution, prejudice, stock jobbing, and competition of low price coal. From this it will be seen that too many efforts have been made with small capital and poor engineering ability to allow the industry to get on its feet, and that has for years given the industry a bad reputation and prevented any attempts being made on a big scale and has generally created ridicule in suggesting a development of a peat fuel industry. With the present high price of fuel and the inability to obtain a steady supply, a peat fuel industry is now looked upon as a remunerative possibility.

There is more than one way of utilizing peat for the production of industrial power, yet whatever method is used the peat must first be excavated from the deposit, and the economic excavation of peat has been the biggest bugbear in the peat industry.

Operation Feasible Only in Dry Season

The average peat deposit contains from 80 to 90 per cent water, and that must be economically driven off to make the peat available as fuel. It will therefore be easily realized that for every ton of raw peat excavated there is only 100 to 400 lb. of theoretically dry peat available. Peat deposits vary, and according to the grade of decomposition they will dry in the air at various rates. The more highly a peat is decomposed the quicker it will allow the moisture to evaporate and the more fibrous the material is the slower it will evaporate. This phenomenon is due to the fact that the moisture present is not all there as absorbed moisture, but the water present is in the cells of the vegetable mass. It is therefore necessary in most cases to pass the peat through a pugging or macerating mill.

Dependence on Local Climatic Conditions

In order to obtain a cheap fuel it can be inferred that peat cannot afford to be handled very much, and therefore the largest part of the drying has to take place on or near the deposit. It is manifestly unfeasible to use any artificial heat for producing peat fuel. However, there are conditions where waste heat can be used to advantage to reduce the moisture content of peat, as will be shown later. There is no cheaper method of drying than by nature herself, and the sun and wind have to accomplish the largest part of the drying in any development of a peat fuel plant. This shows how dependent the industry is on local climatic conditions—not only on the total hours of sunshine, but also on the winds and humidity of the atmosphere. Further the temperatures of the season play a big factor in the excavation and drying of peat; it is impossible to excavate peat when the ground is frozen. In other words, enough material has to be excavated in the good season of the year to supply a plant for the whole twelve months, and this is the point that so many plants have failed to realize, so that they have been forced to shut down for lack of material. The length of time that excavation work can take place varies with the location of each deposit and due regard must be taken of the climate of the locality.

Mechanical Excavating and Handling Apparatus

In most countries the peat is commonly used as fuel and the hand digging of peat is still used. The mechanical handling of peat, which originated in Germany, is only being taken up by deposits where large amounts of peat have to be excavated. Where peat is used as an industrial fuel, only mechanical excavating and handling apparatus can be considered. There are two possibilities of opening up a peat fuel deposit or peat bog; namely, the operation of excavating a dry peat bog and the excavation of peat from an undrained swamp.

In the first case that part of the deposit which is to be used is drained, generally by preparing small ditches which lead into a main ditch. The deposit is then cleared and leveled so that the surface can be used as a drying ground. These ditches should not be too deep and should not go beyond the depth of the deposit to prevent in the latter case contamination with mineral substances. It is often necessary during the winter season to allow the water to accumulate in the deposit and in case the deposit takes fire it can be quenched by allowing the water to rise in the ditches.

The machines used for excavating the peat are generally of the simplest form of construction and are similar to those used ordinarily in ditching and digging. The modern tendency in using power ditching machines corresponds to the types of side chain and bucket excavators, which are very effective in peat which is well decomposed, but cause trouble in poorly decomposed deposits on account of tree stumps which have not yet disintegrated. These machines generally work from the side of the ditch, which has the advantage of mixing the peat from the different depths and thereby securing a homogeneous product. On account of the high cost of labor in this country the peat excavated, even in small plants, is found to be done more economically by machines than by hand digging. The steam shovel has also been used in this country and gives satisfactory results. On account of producing homogeneous material and the ability to spread the material easier on the drying ground, the chain and bucket excavator seems to be most favored.

Difficulties to Be Overcome

In devising machines of this nature not only has the ability of excavating efficiently to be taken into consideration but also the expense and labor incurred in handling the material after it leaves the excavating machine. As peat deposits will not hold a very great weight per square foot, thought has to be given to properly mount the machine so that the weight is distributed as uniformly as possible. The machines are generally mounted on cars having wheels with very wide treads, which have on some deposits, even then, to be supplemented by timbers. The more modern machines are provided with caterpillar tractors, which have proved very satisfactory in this kind of work. Where possible these machines are operated by elec-

tricity, otherwise the power plant has to be installed on the machine. However, this should be obviated as far as possible on account of the possibilities of setting fire to the deposit during the dry season. Peat fires can become very disastrous and are often very hard to put out.

No Standard Peat Digging Machines

There are no standard peat digging machines in this country, and generally in each case they have to be designed to meet the local conditions. These machines have to be of an efficient form and provided with a hopper for receiving the peat which falls into a cutting or macerating trough, thus pulping the peat and cutting up its strands. These macerating machines are provided with screw conveyors and on the same shaft can have knives for cutting up the fibers, while other machines have sections provided with both fixed and movable knives which work together like the blades of scissors.

After the peat has passed through the above-mentioned machinery, it is then spread on the drying grounds, which is generally the surface of the deposit, and here exposed to the sun and wind. Every once in a while a new surface of this layer is exposed and eventually the material is scraped together and hauled to the plant. By this method peat originally containing 80 to 95 per cent water can be dried down to 25 to 35 per cent water right on the field, and this moisture content is low enough where peat is used in gas producers, but for cases where it is used for making steam direct it should be dried down to about 15 per cent water, although 20 per cent is frequently used; in a large power plant this can generally be accomplished at the plant, where enough waste heat exists to reduce the moisture content economically.

In excavating an undrained deposit the machinery has to be mounted on a barge or float and either a dipper-dredge or pumping system is used. Both of these systems are satisfactory; their use depends entirely on the local conditions, quantity of peat to be handled and its stage of decomposition. In each case, however, the peat has to be handled on drying grounds after it leaves these excavating machines. Highly decomposed peat can be very efficiently handled by pumping if very little fibrous matter is present in the deposit.

Costs and Methods of Burning Peat

The cost of excavating and air drying peat governs the success or failure of a peat fuel plant. All the cost involved in handling the peat from the deposit to its storage pile should not exceed $1.30 per ton of theoretically dry peat. The cost depends very much on the size of the excavation plant and on the climatic conditions. My experience in excavating peat covers a cost ranging between 25c to $1.30 per ton of theoretically air-dried peat on the field. It is seldom that the excavation price exceeds $1 per ton of peat, the average being in the neighborhood of 75c. per ton of theoretically dried peat.

In producing power from peat we have available the same methods as are now used for coal, either firing peat direct under a boiler for raising steam or gasifying it in gas producers and using the gas in gas engines or under boilers and in furnaces. Where industrial power is produced from peat, it is necessary to locate the power plant at the edge of the deposit or in very close proximity thereto. The reason for this is that the handling of large quantities of peat fuel involves several problems of a serious nature; on account of its bulkiness and low heating value, compared to coal, it necessitates handling larger volumes and burning an appreciably larger quantity than is the case when coal of a good quality is used for raising steam. Furthermore, very large stocks of peat fuel have to be held, and the sensible heat contained in the flue gases, together with exhaust steam, is used to advantage in reducing the moisture content of the air-dried peat. Peat fuel generally burns freely to a fine easily handled ash. Thus it is practically totally combusted and the handling of the ash is reduced to a minimum.

Analysis of Good Peat Fuel

An approximate average analysis of a good peat fuel is as follows:

	Per Cent
Volatile matter	60
Fixed carbon	30
Ash	8
B.t.u., 8,500	

When peat fuel is burned direct on a grate it is necessary that not too much fine material is mixed in the lumps and it is therefore frequently advisable to briquet the peat before using it for such purpose. Many peats have enough binding material present in them and others will not hold together at all unless mixed with pitch or similar material. In making machined peat it is advisable to form the bricks while the peat is still plastic and then let them dry. Some peat briquets form easily without the addition of any foreign binder, especially when heated up to about 100 deg. C., when the natural paraffine present will hold the peat in its form and produce briquets which are comparatively easy to handle.

Requisites of Boiler for Using Peat Fuel

The points to be considered in constructing a boiler for using peat fuel are a large grate area with very small air spaces, large combustion chamber, and long travel for the flue gases; 15 lb. of peat per sq.ft. of grate per hr. has been found good in practice. Peat has a disadvantage in allowing unburned hydrocarbons and hydrogen to escape in the ordinary combustion chamber built for burning coal. It is therefore necessary to have a specially constructed combustion chamber to insure complete combustion when using this fuel. Peat has another disadvantage, because when firing with peat the fire door has to be open quite a considerable part of the time, because men cannot handle as much peat on a shovel as coal owing to its low specific gravity. However, if the peat is used as a pulverized fuel it will be found not only economical to prepare but can compete with coal more advantageously.

When peat is dried, even air dried, it does not absorb moisture from the atmosphere very readily, and even with 20 to 25 per cent moisture content it has the physical characteristics of a dried material. Provided it has been properly macerated it is very easy to pulverize and will not pack, running and behaving similarly to dried sand. With these conditions, together with its low specific gravity and high combustibiiity, it makes an ideal powdered fuel. Peat has been used in this way in Sweden and has shown that it is possible to obtain better calorific value than by burning the peat on a grate, and every indication points to the fact that peat fuel can be used practically and commercially for

raising steam when used as a powder, so the future developments of the use of peat as an industrial steam raiser will tend to be in this direction.

Cost at Which Peat Can Compete With Coal

The maximum cost per ton which peat fuel can stand and still compete with coal is governed by the cost of steam coal at the place where the power plant is located. There is, however, a fixed minimum cost, determined by the cost of its manufacture, below which peat fuel cannot compete with coal. Peat used directly under a boiler for raising steam can generally compete with good steam coal costing $4.50 or less per ton or $4 or less per ton when the peat is used in a pulverized condition. Above this price where peat deposits which are suitable for fuel are available, they become a serious competitor of coal. The more economical method to convert peat fuel into power is to burn the same in a producer to form combustible gases and then use gas engines or burn the gas under boilers to obtain the desired results.

Inasmuch as peat used for generating steam contains generally from 16 to 21 per cent moisture, less water is evaporated than would be the case if peat were theoretically dried. Peat of this nature directly on the grate will evaporate on an average 4 lb. of water per lb. of peat, while pulverized peat evaporates about 5.25 lb. of water per lb. of peat powder.

Peat Producer Gas

The most economical method for producing power from peat is to convert the peat into combustible gases in a specially constructed gas producer, or if the gas contains any nitrogen to burn the same in a byproduct recovery producer. Since several of the peats examined in this country have a high nitrogen content, it would be possible to recover the largest part of this nitrogen in the form of ammonia.

The commercial use of peat in gas producers seems to have been successful in Germany and Sweden, where they have been used for several years in metallurgical operations, brick and glass making and in lime burning. Tests have been made on this continent both in Canada and at the fuel-testing stations of our Government, where it has been shown that gas of good calorific quality can be produced, similar results being obtained as in producer gas from bituminous coal. About 40 cu.ft. gas is produced from a pound of peat having a calorific value from 130 to 150 B.t.u. per cu.ft. These producers have the great advantage that peat containing as high as 25 per cent or over of moisture can be used. The most economic method of course for using this is for driving gas engines, but engines of large units have not yet proved very satisfactory in this country. In Europe they are operating and have been for a large number of years apparently with a high degree of satisfaction. It therefore appears that for the present it would be most desirable to use this gas under boilers for raising steam.

Ammonium Sulphate Successfully Recovered Abroad

When the peat contains nitrogen, the latter is converted in the producer to ammonia, which can be recovered as ammonium sulphate and prove very profitable. There are several plants in existence in Germany, Italy, Holland and France where the Mond producer, modified by Lihme, is working very successfully. In these producers, gas of about the same quality and quantity as described above is obtained and in addition thereto about 80 per cent of the nitrogen is recovered as ammonium sulphate. These producers are very useful to the peat industry inasmuch as peat containing as high as 42 per cent moisture can be used satisfactorily. In Germany peat containing 50 per cent water and 1.05 per cent nitrogen has been operating for eight years or more delivering a gas of 150 B.t.u. and producing 70 lb. of ammonium sulphate per ton of theoretically dried peat. The nitrogen content of the Italian peat is 2.3 per cent and they recover 215 lb. of ammonium sulphate per ton of theoretically dried peat.

Previous to the war the peat was excavated, dried and conveyed to the producers at a cost of 60c. per ton of peat (theoretically dried). In an ammonia recovery producer the ammonium sulphate obtained will generally cover the total cost of the peat and also the maintenance and operating expense of the gas plant, and even then show a profit. When peat has to be converted into combustible gas it is very easy for a power plant to take this gas and use it for raising steam or generating power by direct explosion in a gas engine. The gases from a peat producer are composed on an average of 20 per cent carbon monoxide, 9 per cent carbon dioxide, 1 per cent ethylene, about 4 to 5 per cent methane and 6 per cent hydrogen; while an average gas from an ammonium recovery producer contains 10 per cent carbon monoxide, 20 per cent carbon dioxide, 20 per cent hydrogen and 5 per cent methane. The building of large gas engine units to use low power gases cannot be an impossibility. Since this has been achieved satisfactorily in Europe, our American power engineers must make up their minds to design an efficient engine of this type, else they will have to be imported from Europe. The power engineer can easily realize from the figures given that we have here an economical and cheap source of power, but it must be realized that economic results cannot be obtained unless large installations are designed and that our capitalists must be willing to break a new path in developing and utilizing a resource so easily obtainable.

Conclusion

There is no difficulty whatsoever in either using a peat for steam raising as a powdered fuel or using a peat in a gas producer. The difficulties, or better the failings, in producing peat as a source of fuel lie in the lack of attention which has been paid to the excavation and drying of the same and the poor engineering ability which has tried to overcome these troubles.

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Concrete Tanks Used for Water Storage

The test of concrete tanks made of 1:2:4 mixture and used for water storage, undertaken by the Bureau of Standards, Department of Commerce, has been discontinued after 150 days because the day-loss curves have taken the form of a straight line, showing that the daily loss has become constant. It may be of interest to note that these tanks, although showing some actual loss, due to water penetrating the concrete, remained dust dry on the exterior. It would seem from this that although the head of water was 35 ft., the mixture is sufficiently waterproof for this purpose.

Aluminum Rolling-Mill Practice—V Finishing Operations

Production of Thin Sheets to Exact Gage, Hardness and Required Surface Finish Is Described in Detail, Together With the Associated Shearing, Annealing, Inspecting and Shipping Operations*

By ROBERT J. ANDERSON and MARSHALL B. ANDERSON

PRIOR to finishing and after the slabbing operation, aluminum slabs are roughed on roughing mills. In general, all sheets which are to finish lighter than 0.080 in. (2 mm.) thick are roughed to within two gage numbers of the finished gage e.g., slabs which are to be rolled into 16-gage sheets are roughed to 14-gage. There are certain exceptions to this rule, and these will be pointed out later.

Ordinarily, sheets which are to finish wider than 48 in. (1.2 m.) and longer than 144 in. (3.7 m.) are rolled singly, while smaller sheets are rolled in pairs. When roughing singly, only one sheet is on the mill, but when rolling in pairs, the roller is passing one sheet through the rolls while the catchers are returning the other sheet over the upper roll. One roller and two catchers can operate a roughing mill, and the production is variable—from 500 to 1,000 lb. per hr. (225 to 450 kg.). The number of passes given, during roughing, and the percentage of reduction depend upon the size and gage of the desired sheets, and to a less extent upon the condition of the mill. Under normal conditions, ten to forty passes are given with three or eight sets of the mill, the variations being due to the gage and the condition of the mill.

After cold roughing, the ends of the rough sheets are sheared so as to prevent undue cracking on finishing; ordinarily, only a small amount of scrap results here, and shearing may be omitted if the ends of the sheets are in good shape. As a matter of fact, it is better to say that sheets to be rolled in pack (20-gage and lighter) are sheared, while those rolled singly (heavier than 20-gage) are not. In general, however, sheets for pack finishing are sheared on both ends and sides, because they are more liable to crack during finishing than the heavier gages.

As has been mentioned above, all sheets, with some exceptions, are roughed to within two gage numbers of the finished gage. In rolling 20-gage (0.81 mm.) sheet, however, the slabs are roughed to within one number of the finished gage, i.e., 19-gage. In roughing, 20-gage is run two in a pack, and the roller will roll one sheet at a time until the sheets are thin enough to run in pack. For 20-gage sheet, the hot-mill slab is cold slabbed to ⅛ in. (3.2 mm.) and during preliminary roughing the roller will take one sheet and make about six to eight passes with two sets of the rolls. This is repeated for three other sheets, so that the metal is finally run two in a pack and in pairs, i.e., there will be four sheets on the mill. While the roller is passing one pack through the mill, the catchers are passing the other pack back to the roller over the upper roll. As each pack is finished, the metal is stacked on trucks adjacent to the mill by the catcher.

When aluminum is rough-rolled, it is dull gray in color, as no buffs are used on the roughing mill. During roughing, the rolls and the rough sheets are occasionally rubbed over with a swab soaked in kerosene, so as to prevent the metal from sticking to the rolls.

An indicated above, some rough sheets are sheared so as to lessen the liability of further cracking during finishing. All sheets to be run in pack are sheared ½ in. (1.3 cm.) on each side and whatever amount on each end as is necessary to remove the cracked metal at those places. Occasionally, thick sheets run singly crack during the roughing operation; it is then necessary to shear off the cracked metal so as to prevent further cracking. Cracking during rolling may affect the total scrap loss if it becomes excessive.

Finishing Aluminum Sheets

Cold finishing to gage is performed upon a mill similar in its general features to a roughing mill except that buffs are used on the rolls to keep them polished. Most of the sheet aluminum is sold as planished sheet, i.e., highly polished, and the rolls must be kept bright and free from dust and flakes of aluminum.

Two buffs are used on each mill, one for each roll. Buffs are made by nailing two 1-in. boards together at an angle of 90 degrees; the boards should be 4 to 6 in. wide; the lower board should be as long as the rolls are wide, but the upper board should be sufficiently longer so that it may rest on the roll boxes. The space in the 90 degree angle is filled with waste, and heavy duck is tacked from one board to the other so as to hold the waste in place. Then two pieces of cloth, the length of the boards and 8 to 10 in. wide, are placed together and nailed to one board so that the free end may drag on the roll. The buffs, built up in this way, are secured with bolts and nuts to the roll box so that they rub against the revolving rolls.

A product known as "gray plate" is manufactured on finishing mills with the buffs removed. The surfaces of so-called "finished sheets" are bright and glossy, while those of gray plate are dull and gray. Gray plate is run most often in 14- to 17-gage, and is used considerably for cooking-utensil stock. Gray plate is cheaper to manufacture than finished sheet, for it can be rolled faster. Indeed, manufacture of gray plate may be regarded properly as roughing to finished gage.

In the manufacture of planished sheet aluminum, the finishing operation calls for running down the rough sheets with from twenty-five to forty passes with one set of the rolls, which brings the sheet nearly to gage; the rolls are given such an additional set as will bring

*For parts I, II, III and IV see CHEM. & MET. ENG., March 17, 24, 31 and April 7, 1920, pp. 489, 545, 599 and 647.

the sheet exactly to gage with five or six additional passes. After finishing to gage, the metal will be sent to the squaring shears, where it will be cut square to the required sizes.

Ordinarily, sheets to finish 20-gage and lighter are run in pack, while heavier sheets are run singly. The number of sheets per pack varies with the gage and depends upon whether the ultimate sheet is to be dead soft annealed or hard rolled. If dead soft annealed sheet is being rolled, more sheets can be run in a pack for a given gage than where hard rolled or intermediate sheet is desired. This is so because the soft sheets will be annealed after finishing, and annealing will remove any buckles or waves in the metal. If too many sheets are rolled in pack for a given gage, the ends will curl up, and it is exceedingly difficult to straighten the metal later. As a rule, however, the number of sheets per pack for various gages will be about as shown in Table XIV.*

Light gage sheet must be rolled in pack, because it is otherwise impossible to reduce the metal to gage; this is true for the reason that the rolls are nearly tight from 26-gage (0.4 mm.) up, and to reduce the metal it is necessary to roll several sheets together. Rolling in pack might appear to be a method of speeding up production, but this cannot be regarded as a correct statement for a wide range of gages. Thus, while it is possible to roll more 20-gage sheet in pack than 18-gage singly, it is not possible to roll lighter gages in pack as fast as say 10- or 12-gage.

The figures in Table XIV vary with the condition of the mill, the kind of sheets rolled, and the iron content of the aluminum. As a general procedure, sheets to be rolled in pack are first given a few passes singly (starting with the already roughed sheets); they are then rolled two in a pack, then three, and so on; as the thickness is reduced, the pack is built up. In rolling to gage, whether singly or in pack, the rolls are occasionally swabbed off with kerosene so as to prevent the sheets from sticking. Production is variable, depending upon the gage and size of sheets; figures obtained vary from 100 to 200 lb. per hr., and a yearly average for a plant of capacity 25,000 lb. (11.5 metric tons) per day was 120 lb. (54 kg.) per hr.

Flattening

In order to remove slight buckles and waves in aluminum sheets and make them flat, the sheets are run through a "flatter." Flattening is an effective operation on sheets from 8 to 17 gage (3.26 to 1.15 mm.). Where a perfectly smooth, unmarked surface is called for, flattening should not be attempted, since the flatter rolls may mar the surfaces of the sheets. As a matter of fact, however, sheets should be made on the mills and not on the flatter, and buckled sheets are due to high ridges on the rolls.

Finish Shearing

Commercial aluminum sheets as they appear on the market are finish sheared, squared, and cut to the desired size. The scrap loss arising from shearing may, at times, be considerable, and this is usually the result of mis-shearing and poor finishing practice, although the condition of the metal and the mills, the previous roughing, hot rolling and calculations may all be contributory factors. When sheets are to be cut to a specified size, the usual scrap allowances for shearing on the sides and ends are as given in Table X.†

Shearing, as already pointed out, is a simple mechanical operation, devoid of any features of descriptive interest, but it should be performed by competent shearmen; poor shearing practice invariably leads to high scrap losses and increases production costs. If sheets are sheared too large, they must be re-sheared, and if cut too small they must also be re-sheared to work them into other orders.

Some sheet aluminum goes on the market in the form of circle stock, particularly for the fabrication of aluminum utensils. Much circle stock is made from strip-rolled metal; the strips are sheared into squares; and these are cut into circles on a circle shear allowing ½ in. for scrap, i.e., a side of the square should be 1 in. (2.54 cm.) greater than the diameter of the desired circle. The usual practice in circle shearing is to shear before annealing, since soft metal will bend too readily and get out of shape; further, annealed aluminum will burr badly on shearing. This can be avoided entirely by shearing cold-rolled sheets and strip.

Strip Rolling Aluminum

As previously mentioned, some sheet aluminum is finished to gage on strip mills, so called because narrow slabs or strips are rolled. The product is known as strip metal, coils, etc. It has been said that D and E ingots‡ may be used for strip rolling because the metal is here drawn out rather then spread. High-scrap ingots will result in heavy losses due to cracked sheets in finishing mills, but these ingots work very well in strip mills. Slabs for strip rolling are sheared on both ends and sides, and the slab is reduced to gage with from ten to twenty passes; for example, a ⅜-in. or a ¼-in. slab will be reduced to 14- and 20-gage respectively with about fifteen passes (9.5 or 6.4 mm. is reduced to 1.63 or 0.81 mm.). The first passes should be heavy and the last ones light.

A special lubricating oil is used to lubricate the rolls, but if used in excess as the strip is nearing gage, it does not allow a bright finish on the surfaces of the strips. Hence, on the first two or three heavy passes, it is good practice to use much oil, and as the reductions become lighter as the metal nears gage the excess of oil should be removed. In that way, a bright, glossy appearance will be imparted to the sheets.

There are but two rolling operations in the manufacture of strip metal, viz., hot rolling and strip rolling; no slabbing or roughing is performed. Three men can operate a single unit strip mill, i.e., one roller and two catchers. As a strip becomes elongated by rolling, it becomes increasingly difficult to handle because of its length. Hence, at about 14-gage, the catchers will coil the strip into coil boxes so as to facilitate handling. All strip mills should have a self-coiler as an accessory part; such a coiler will permit a mill to be run with one roller and one catcher. When finished, the strip is cleaned in a strip cleaner and re-coiled.

Strip may go on the market in the form of coils, squares, rectangles, circles, etc. Narrow coils are manufactured by slitting a wide coil into several long pieces on a gang shear, which also rewinds the separate coils so produced. The slab-shear scrap from the strip mill will be greater in quantity than from finishing mills,

*Chem. & Met. Eng., vol. 22, No. 13, March 31, 1920, p. 604.

†Chem. & Met. Eng., vol. 22, No. 13, March 31, 1920, p. 601.

‡Chem. & Met. Eng., vol. 22, No. 12, March 24, 1920, p. 548.

because all slabs for strip metal are sheared on both ends and sides; usually slabs for sheets are sheared only on the ends.

Strip Cleaner

Strip-rolled aluminum is cleaned in a strip cleaner for the purpose of removing lubricating oil. Any oil remaining on the metal will result in a brown or black discoloration on subsequent annealing. A strip cleaner may consist of a cast iron vat supported on four legs; inside dimensions of the vat may be about 4 x 6 ft. (1.2 x 1.6 m.). At one end of this vat, a smaller vat is fastened; this latter is filled sufficiently full with gasoline, and the coil of strip is run through the gasoline. At the other end of the larger vat, a self-coiler is attached. A series of motor-driven rolls for guiding the metal is placed at intervals in the cleaner, and the large vat should be filled with sawdust. To clean a strip, the coil will be placed in the vat of gasoline and one end of the strip will be forced through the rolls, down into the sawdust, and up through a set of revolving brushes to the self coiler.

In some places, soap and water has been used instead of gasoline; a soap which will emulsify the oil on the strip may be effective, but it is the writers' experience that it is far safer to use gasoline for effective cleaning, in spite of the fire hazard. Carbon tetrachloride is a highly effective agent for removing strip-metal oil, but the cost is much higher. Too much emphasis cannot be laid upon proper cleaning of strip coils which are subsequently to be annealed.

Production of Intermediate Sheets

Aluminum sheets, whether finished, gray plate, or strip rolled, may be furnished in various hardnesses; sheets are thus furnished as soft annealed, intermediate, and hard rolled. The hardness is usually measured by the Shore scleroscope, which, while it cannot be entirely accurate for light gages, is sufficiently accurate for all practical purposes. Soft annealed sheets are produced by annealing the products of the finishing and strip mills, while hard-rolled sheets constitute the products of these mills. Intermediate sheet may be in various hardnesses between those of annealed and hard rolled sheet.

In dealing with sheets of intermediate hardness, it is convenient to use a series of symbols for different kinds of sheet. Thus, suppose dead soft annealed sheet is called *XA*0 and hard rolled sheet is called *XAH*; then sheets of intermediate hardness may be called *XA*2, *XA*4, *XA*6 and *XA*8. Provided the previous percentage of reduction is the same for all gages, it is correct to say broadly that the Shore hardness numbers corresponding to these grades in aluminum sheets will be as shown in Table XVI. The methods of manufacturing intermediate sheets are perforce empirical, and a large number of combinations are possible. It is possible to produce intermediate sheets by annealing the partly finished sheet at a gage equal to the finished gage minus the number indicating the intermediate hardness desired. Thus, in making *XA*2 sheets, 18-gage, the partly finished sheet would be annealed at 16-gage, or after roughing. If *XA*6, 18-gage sheet was to be made, the annealing would be done at 12-gage (in the roughing operation); after annealing, the rough sheets would be brought back to the mill, roughed to 16-gage, and then sent to the finishing mill. In the manufacture of *XA*½*H*, or *XA*7, 16-gage, it is necessary to anneal at ⅛ in. in the slab; that is to say, the hot-mill slab is cold slabbed to ⅛ in., and then annealed. The annealed slab is then sent to the roughing mill and roughed to 14-gage, and finally sent to the finishing mill and finished. More simply explained, a broad dictum may be laid down with regard to the annealing for the production of intermediate sheets: Usually such sheets will be annealed *n* gage numbers from the finished gage, where *n* may be 2, 4, 6, 8, etc., in the terminology *XA*2, *XA*4, *XA*6, and so on.

TABLE XVI. SHORE HARDNESS NUMBERS FOR VARIOUS GRADES OF ALUMINUM SHEETS

Grade	Shore H. N.	Grade	Shore H. N.
XA0	4 to 5	XA6	10 to 11
XA2	6 to 7	XA8	12 to 13
XA4	8 to 9	XAH	14 to 15

Annealing Aluminum Sheet

The usual practice employed for annealing cold-rolled sheet aluminum entailed heating the metal for periods of time varying from 18 to 30 hr. at about 370 deg. C. Late reports indicate[9] that at some plants this annealing period has been changed to 2 to 5 hr. at 350 to 500 deg. C. The shorter period is certainly a much more rational procedure, because hard-rolled aluminum may be softened with only short annealing periods at moderate temperatures.

At the present time, aluminum sheet is annealed in gas- or oil-fired furnaces and in electrical furnaces. The car-type electric furnace shown in Fig. 3 has been used for annealing; accurate control of the annealing temperatures is readily possible in this furnace. Annealing furnaces may be built in various sizes according to the desired capacity; for example, a furnace may have inside dimensions of 35 ft. long x 8 ft. wide x 6 ft. high (10.7 x 2.4 x 1.8 m.) The shell of the furnace is built up from ⅜-in. (10-mm.) steel plates, held together with rods and I-beams; adjacent to the steel plates is a layer of common brick, then a layer of kieselguhr, and then a lining of firebrick.

Metal to be annealed is placed upon large iron plates in staggered piles, so as to allow free access of the heat to all parts. The plates with the piles of aluminum are placed by crane upon small cars, and these are pushed into the furnace. It is convenient to have the tracks for the cars extending to about 20 ft. (6 m.) beyond both the front and rear doors of the furnace, so that the cold metal to be annealed may be loaded at one end, and the annealed metal withdrawn from the other end. After the anneal, the aluminum is removed from the furnace and allowed to cool in air.

Some further aspects of the annealing and recrystallization of cold-rolled aluminum sheet have[10] already been dealt with by one of the writers, and these matters will not be further amplified in this place. It will be pointed out again, however, that cold-rolled aluminum sheet after various heavy reductions may be softened to 4 to 5 Shore hardness by relatively short annealing periods at moderate temperatures. For an-

[9] Dwight D. Miller, CHEM. & MET. ENG., vol. 19, 1918, p. 254.

[10] Anderson, Robert J., "Erichsen Tests on Aluminum Sheet," *Iron Age*, vol. 101, April 11, 1918, pp. 950-951; "Annealing and Recrystallization of Cold-Rolled Aluminum Sheet," MET. & CHEM. ENG., vol. 18, May 15, 1918, pp. 523-527; "The Testing of Sheet Aluminum," *Iron Age*, vol. 102, July 18, 1918, pp. 148-149; "Annealing Cold-Rolled Aluminum Sheet, etc.," *J. Inst. Metals*, vol. 20, No. 2, 1918, pp. 203-220; "The Metallography of Aluminum," *J. Frank. Inst.*, vol. 187, January, 1919, pp. 1-47.

nealing slabs and large sheets, a car-type furnace appears to be entirely satisfactory. For annealing utensil stock, a continuous furnace will doubtless prove more advantageous.

Inspection of Aluminum Sheet

After aluminum sheets have been rolled to gage, sheared to size, and annealed if necessary, they are sent to an inspection room to avoid much trucking of the metal back and forth. Sheet aluminum may be inspected conveniently on benches about waist high. Two men should be able to handle the inspection for a mill rolling 25,000 lb. (11,350 kg.) of sheet per day. Two men are needed for inspecting, because it will be difficult for one man to turn over the larger sheets for inspection on both sides.

In mill practice, carbon copies of the orders or lot numbers should be furnished to the inspector. When a lot of metal is ready the inspector will indicate the total number of pounds accepted and rejected on his carbon copy and return this to the office. The inspector will also keep a detailed account in a book provided for that purpose of the number of pounds of sheet inspected daily, the amount passed, and the amount rejected, and make notations as to the reasons for rejection. The inspector should also collect data daily from the hot mill records with regard to the total weight of ingots rolled, and from the slab-shear reports as to the weight of slabs sheared and the scrap.

With this information, the office should render a monthly report to the superintendent showing the vital figures which affect the operation of the mill. Over a period of a year, such a report will appear as in Table XVII, giving detailed figures for defective sheets and the reasons for the defects.

A detailed explanation of the table may be advisable. Ingot weight refers to the total amount of ingots broken down in the hot mill to slabs during the periods indicated. Slab weight is the total weight of slabs after shearing; the scrap loss due to shearing averages about 10 to 12 per cent for reasons already explained. Where the scrap loss due to slab shearing is less than 10 per cent, this may be due to the fact that the hot roller broke down more ingots than a certain order called for, say eleven ingots instead of ten; the resultant slab weight would be greater than the apparent amount of metal rolled (as shown by the hot-mill lot requisitions). This happens quite often because of carelessness at the hot mill. Figures for total weight of finished sheets rolled are obtained by weighing the lots as they are delivered to the inspection department; weights for accepted and rejected sheets are taken during inspection. The sum of the weights of the finished sheets rejected because of various defects should equal the total weight of rejected sheets shown in column 5 in the table, but usually these weights do not check. The discrepancies result from errors in weighing, and neglecting to weigh part of the rejected material, as well as from mixing accepted and rejected metal. This is due, of course, to carelessness. Scrap losses resulting in rolling aluminum to finished sheets usually average about 35 to 40 per cent, as shown in column 7; this scrap figure is obtained from the formula

$$100 - \frac{\textit{Weight finished sheet rolled}}{\textit{Weight ingots rolled}} \times 100$$

In the same way, the total amount of scrap, including sheets rejected by the inspector, is obtained from the formula

$$100 - \frac{\textit{Weight finished sheets accepted}}{\textit{Weight ingots rolled}} \times 100$$

Defects in Finished Sheets

Usually, all sheets are carefully examined for surface defects, cracks, stains, buckles, scratches, etc. Whether any sheet is rejected or not will depend upon the specifications, if any, and the seriousness of the defect.

Blisters are usually sufficient cause for rejection, and this defect is one of the most serious with which the aluminum-rolling mill is concerned. Blisters are thought to result from annealing at too high temperatures; there is little doubt that high annealing temperatures *per se* are sufficient to cause blistering, but whether this

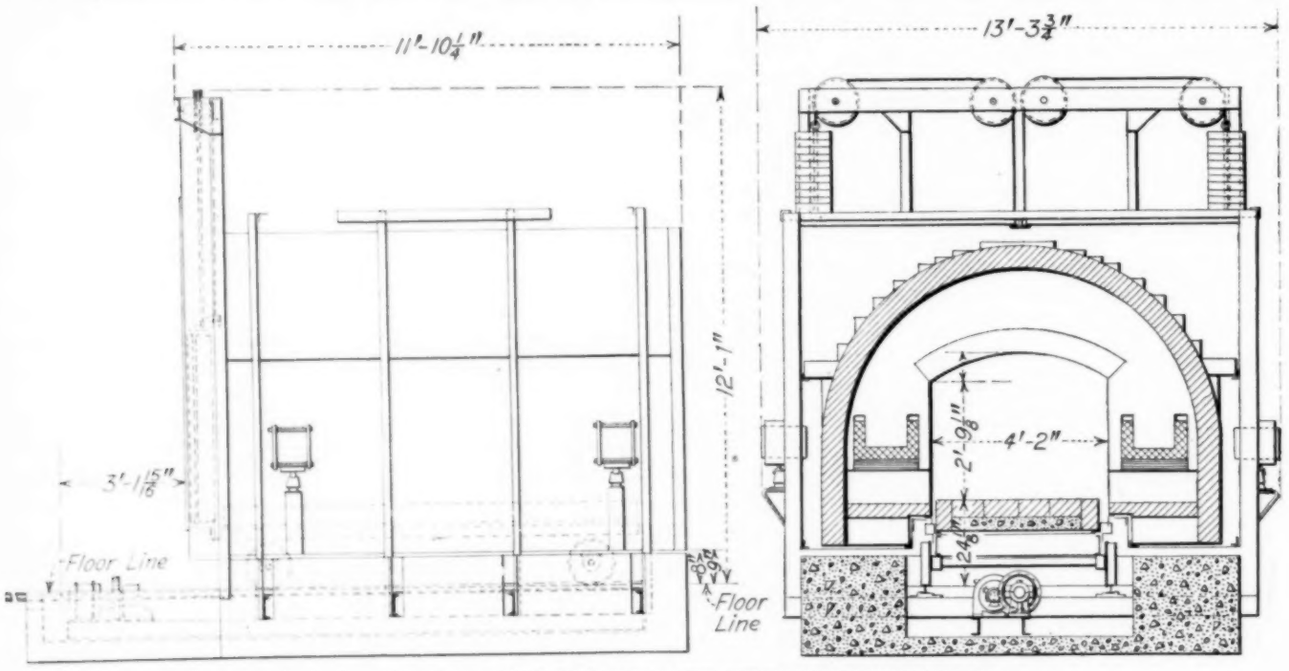

FIG. 5. CAR-TYPE ELECTRIC FURNACE (ELECTRIC FURNACE CO.)

trouble is also intimately associated with gas absorption on melting for casting into ingots is not clear. The facts are that accurate information with regard to this matter is lacking, but corrective measures to reduce the scrap losses from blistering are urgently needed.

In aluminum-rolling parlance, "slivers" are understood to describe the flaking of the metal in long splinters; this occurs on rolling, and entrained dross will usually be found associated with slivers. The explanation offered for this defect is that, during rolling, some of the mechanically entangled dross is forced near the surface of the sheet until this dross is held under a very thin film of metal. The dross is elongated in the direction of rolling, and when finally the film becomes extremely thin, the metal covering the dross flakes off in long splinters—called slivers. This is distinctly a surface defect and ruins the sheets for most purposes.

Roll marks are the buckles or waves in sheets resulting from a high ridge on the finishing rolls; where the sheets must be perfectly free from scratches, the flatter cannot be used for the purpose of ironing out the buckles, and therefore rejections follow.

Scratches result largely from handling. Pulling one sheet over another, so that the slight burr on the edge of the one sheet scrapes across the face of the other is a prolific cause of scratches. Scratches also are the result of handling on shearing, of flattening, and piling and stacking.

Cracks and splits are due to rolling, and often they can be avoided only with much difficulty. Cracks are more numerous in rolling the light alloys than aluminum itself because of their greater hardness. Sheets rolled from ingots made from high scrap heats are also fairly prone to crack on rolling.

"Dirt" means simply the entrained dross which is forced to the surface on rolling; it is sufficient cause for rejection.

Regarding stains, it is advisable to distinguish between oil stains and water stains. Oil stains are usually found on strip rolled metal, and result from the burning of residual oil during annealing. They can be largely eliminated by observing the proper amount of care in cleaning. Oil stains are various shades of brown to black color, and can be readily distinguished from water stains. Aluminum, like copper, may absorb considerable amounts of moisture even on exposure to atmospheres of high humidity; on annealing, this absorbed water is driven to the surface and may cause a whitish stain of a powdery character. This powdery product appears to be oxide of aluminum, although precise information as to its chemical composition is not available. If aluminum sheet, prior to annealing, becomes wetted with water by rain coming in through windows or skylights, it will usually have this white stain after annealing. The stain is objectionable and results in rejection of the sheets.

In column 17 wrong shearing refers to mis-shearing at the finishing shears, and usually sheets sheared wrong are sheared too narrow or too short. "Short" means the fairly large pieces which are found to be too small to shear to the required size; short sheets are the result of miscalculations, rolling the wrong size ingot, cracking on rolling, and shearing to stop further cracking. Short sheets are not necessarily a total loss, although they may not be applicable to the lot in which they were rolled; they are usually worked into other lots by re-shearing to a smaller size, or cut up into squares for circle shearing. Also, short material may

TABLE XVII. ALUMINUM SHEET INSPECTION RECORD

Column	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Month	Total Wt. of Ingots Rolled, Lb.	Total Wt. of Slabs Produced, Lb.	Total Wt. of Finished Sheets, Rolled, Lb.	Total Wt. of Finished Sheets Accepted, Lb.	Total Wt. of Finished Sheets, Rejected, Lb.	Percentage of Scrap—Based on Ingot Wt.: Slab Scrap (*a*)	Finished Scrap in Process (*b*)	Total Finished Scrap (*c*)	Wt. of Finished Sheet, in Lb., Rejected Because of—Stains: Blisters	Slivers	Roll Marks	Scratches	Cracks and Splits	Dirt	Oil	Water	Wrong Shearing and Short	Percentage of Scrap, Based on Finished Wt., Rejected Because of—Stains: Blisters	Slivers	Roll Marks	Scratches	Cracks and Splits	Dirt	Oil	Water	Wrong Shearing and Short	Total Rejection, Per Cent
January	142,091	125,242	83,966	76,859	7,107	11.86	40.91	45.91	1,079	1,113	2,312	897	209	758	143	53	601	1.29	1.33	2.75	1.07	0.25	0.90	0.17	0.06	0.72	8.46
February	148,778	129,169	83,041	76,087	6,954	13.18	44.18	48.86	1,363	1,395	476	1,799	211	165	414	104	1,025	1.64	1.68	0.57	2.17	0.25	0.20	0.50	1.23	1.23	8.37
March	164,998	145,210	100,069	88,769	11,300	11.99	39.35	46.20	3,414	1,669	964	1,938	387	216	191	....	1,248	3.41	1.67	0.96	1.94	0.39	0.22	0.19	0.10	1.25	11.29
April	140,138	124,094	84,387	78,985	5,402	11.45	39.78	43.64	1,498	297	194	116	587	301	....	....	2,401	1.78	0.35	0.23	0.14	0.70	0.36	....	....	2.85	9.40
May	164,589	149,247	107,114	103,561	3,553	9.32	34.92	37.08	697	88	87	166	....	....	2,355	....	2,371	0.65	0.08	0.04	0.08	0.15	....	....	....	2.21	3.32
June	200,881	181,516	131,019	123,752	7,267	9.64	34.78	38.40	1,739	....	415	72	956	....	2,100	982	663	1.33	....	0.32	0.05	0.73	....	1.80	0.75	0.51	5.55
July	126,046	110,641	75,264	66,084	9,180	12.22	40.29	47.57	4,885	78	....	....	40	57	1,914	877	758	6.49	0.10	....	....	0.05	0.08	2.79	1.28	1.01	12.20
August	192,569	173,346	120,261	109,569	10,692	9.98	37.55	43.10	1,967	198	162	113	1,009	113	1,914	877	4,315	1.64	0.16	0.13	0.09	0.84	0.09	1.59	0.73	3.59	8.89
September	146,875	132,213	91,669	84,882	6,787	9.98	37.59	42.21	2,669	427	181	....	18	168	182	165	2,446	2.91	0.47	0.20	....	0.02	0.18	0.20	0.18	2.67	7.40
October	198,403	174,427	112,294	101,267	11,027	12.08	43.40	48.96	2,678	2,013	537	....	430	265	1,015	1,628	2,176	2.38	1.79	0.48	....	0.38	0.24	0.90	1.45	1.94	9.82
November	180,099	157,988	98,627	87,721	10,906	12.28	45.24	51.29	3,591	1,682	674	283	139	1,044	715	597	2,094	3.64	1.71	0.68	0.29	0.14	1.06	0.72	0.61	2.12	11.06
December	144,757	127,924	82,523	75,576	6,947	11.63	42.99	47.79	1,229	57	681	11	143	2,817	229	735	873	1.49	0.07	0.83	0.01	0.17	3.41	0.28	0.89	1.06	8.42
Totals	1,950,224	1,731,017	1,170,234	1,073,112	97,122	....	....	....	26,809	9,017	6,637	5,316	4,295	5,904	9,258	6,105	20,971	....	....	....	....	....	....	....	....	....	....
Averages	162,519	144,251	97,520	89,426	8,094	11.30	40.08	45.08	2,234	751	553	443	358	492	772	509	1,748	2.39	0.78	0.62	0.49	0.34	0.56	0.76	0.50	1.76	8.20

1 lb. = 0.454 kg. *a* This figure includes shearings, buckled and twisted slabs, etc. *b* Finished scrap in process refers to the scrap resulting in the manufacture of finished sheets, exclusive of inspector's rejections, and includes shearings, buckled sheets, etc. *c* This figure embraces all the scrap, and includes the finished scrap in process, plus the inspector's rejections.

be put in stock and allowed to accumulate for a given period of time.

Inspection Record

If properly interpreted, inspection records are very valuable for the purpose of deciding what preventive measures must be taken to reduce scrap losses. In fact, if scrap figures are plotted weekly in the form of graphs, the interpretation may be readily had at a glance. It is not possible, in the present article, to deal with this subject in exhaustive detail, and it is the writers' object now merely to afford an insight into how inspection records may be gathered and their data interpreted. Both blisters and slivers are difficult to eliminate if high scrap ingots are rolled, but measures for preventing scratches are more obviously and easily applied. After all, the predominating factor which determines the scrap losses in aluminum rolling-mill practice, as in any other industry, is the quality of the supervision.

Shipment of Aluminum Sheets

For shipment, aluminum sheets are packed in paper and boxed or crated. Because of the relatively high value of the metal in sheet form, the packing and shipping should be carefully done. If sheets are loosely packed, so that they slide on one another in transit, there is danger of scratching even though the sheets left the mill in perfect condition.

Commercial Pottery of Japan

IT IS characteristic of Japanese ceramics that the numerous varieties have always been distinguished from one another geographically rather than technically. Thus Satsura ware, Imari ware, Awata ware, etc., names well known to foreign connoisseurs, refer to the districts in which the pottery is made. Japanese wares may be classed roughly in three groups:

1. Stoneware, including tiles and various utility objects, usually glazed and ornamented only by stamping or scoring, made in many parts of Japan and chiefly consumed locally.

2. Faience, most often with a crackle glaze, and highly decorated. It is not fired at so high a temperature as porcelain and is consequently softer and more fragile; but, for the same reason, more delicate colors may be used in decoration. Much of this sort of ware has found its way abroad under the designation of "curios."

3. Hard porcelain and semi-porcelain.

The porcelain of Japan is made in a different way from that of China. Having been fashioned, it is baked in a biscuit state, then painted with such colors as require a great heat and the glaze applied, then burned again at a much higher temperature; any further decoration in enamel colors or gilding is subsequently fired in a muffle kiln. These numerous firings are less tenacious than those used in China, hence Japanese specimens are frequently slightly out of shape.

Production and Export

The value of the earthenware and porcelain produced in all Japan for the year 1918 was 44,214,084 yen (approximately $22,107,000). The relative production of different classes of potteries for 1917 was as follows: Ornaments and art objects, 18 per cent; dishes, 56 per cent; industrial goods, 10 per cent; toys, 5 per cent; miscellaneous, 11 per cent. Table I shows the production of pottery in Japan for the years 1909 to 1918, inclusive, yen having been converted to dollars at the rate of $0.50 to 1 yen.

A glance at the export statistics will show that whereas in the first half of the decade from 1909 to 1918 the export of pottery from Japan kept about the same figure, yet from the beginning of the war the annual export steadily increased until the amount for 1918 had grown to four times the figure for 1914. Before the war the United States took nearly half of Japan's production, but in 1918 this proportion had shrunk to less than one-fourth.

TABLE I. VALUE OF THE POTTERY INDUSTRY IN JAPAN FOR THE YEARS 1909 TO 1918

Year:	Value	Year:	Value
1909	$6,178,838	1914	$7,828,428
1910	6,634,997	1915	8,766,124
1911	7,447,801	1916	12,610,174
1912	8,272,772	1917	14,669,216
1913	8,838,417	1918	22,107,042

In Table II are given the total values of exports of pottery from Japan for the years 1909 to 1918, inclusive, together with the values of such goods destined to the United States.

TABLE II. VALUE OF THE POTTERY EXPORTS FROM JAPAN FOR THE YEARS 1909–1918

Year	Total Export	Export to United States	Year	Total Export	Export to United States
1909	$2,628,416	$1,448,636	1914	$2,955,884	$1,572,374
1910	2,756,961	1,391,036	1915	3,476,476	1,455,072
1911	2,732,799	1,368,383	1916	6,051,996	1,095,694
1912	2,725,799	1,293,170	1917	7,238,967	2,470,395
1913	3,348,668	1,564,350	1918	9,976,896	2,229,467

The classes of porcelain and semi-porcelain products which enter largely into the export trade are: Tableware, including all the pieces comprised in ordinary dinner sets; sanitary ware, such as washbowls and other bathroom fixtures; electrical porcelain, such as insulators, sockets, etc.; and toys and novelties.

Tables III and IV give the analyses of a few typical Japanese kaolins, clays and porcelain stones.

TABLE III. ANALYSES OF JAPANESE KAOLINS AND CLAYS

Variety	Percentage of SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	H_2O
Shiga-raki (Kipto)	56 87	28 56	0 98	0 69	0 47	2 08	0 06	10 16
Owary (Seto)	54 65	32 35		0 90	0 37	3 27	2 22	6 30
Hizen (Arita)	49 25	38 89	1 14	0 15	0 36	2 01	0 39	5 90

TABLE IV. ANALYSES OF JAPANESE PORCELAIN STONE

Kind of Stone	Percentage of SiO_2	Al_2O_3	Fe_2O_3	CaO	K_2O	Na_2O	H_2O
Arita stone I	78 70	14 27	1 16	0 45	2 24		3 29
Arita stone II	83 00	11 60	0 70	0 18	1 90	0 29	2 49
Amakusa stone	73 87	15 25	0 73	0 43	5 46	1 07	2 23
Kutani stone	76 60	14 75	0 86	0 29	3 91	0 65	2 68

The wages in the Japanese pottery industry are exceedingly low when compared to those received for similar work in the United States. Thus the average daily wages received by the workers during 1917 and 1918 were: Girls under seventeen, 0.60 to 1.20 yen; girls over seventeen, 0.90 to 1.30 yen; men under seventeen, 0.60 to 1.25 yen; and men over seventeen, 1.20 to 2 yen. (1 yen = about 50c.) To these figures must be added a rice stipend granted to equalize the present high cost of living.

Legal Notes

By Wellington Gustin

Governmental Power Over Manufacturers

The manufacturer and others engaged in large business enterprises have felt very keenly within the last few years the encroachment of governmental power and authority.

Just what are the limits of authority of governmental officials is hard to determine. The officials naturally appropriate all possible, feeling that the parties affected will assert their own rights and thus arrive at the proper limitation or line of authority between them. The power and authority of the Federal Government is limited to subject matters granted to it by the states, but just where this line lies is left to a determination by the courts. The power to control and regulate commerce between the states was given to the Federal Government. But what is commerce? Are you engaged in commerce which comes under Federal regulation? Are you simply a manufacturer, and as such, not amenable to certain acts of Congress?

Demand of the Federal Trade Commission

In a recent decision the United States District Court sustained the contention of the Basic Products Co. against the Federal Trade Commission, which body, pursuant to a resolution passed by it, had demanded an opportunity to examine any documentary evidence which related to the organization, business, conduct, practice and management of the corporation and its relation to other corporations, and to individuals, associations and partnerships, in order that copies may be made of any portions of said documentary evidence as appears to be relevant to the subject matter of its "investigation." Among more general demands there was the following: "In particular, the Federal Trade Commission demands that it be permitted to examine and take copies, if deemed advisable, of all documentary evidence which relates to the production costs, annual production, and capital investment in the manufacturing of a commodity known as 'Syndolag.'" After service of this demand certain examiners for the Commission presented themselves at the office of the Basic Products Co. at Pittsburgh to secure the desired information, which was refused. The Attorney General, in the commission's behalf, then asked for a writ of mandamus to compel the Basic Products Co. to allow the investigation of its records as desired. (260 Fed. Rep., 472.)

Secrets Refused by Company

The company answered the petition for the writ, saying it had developed "Syndolag," a patented article, after a great expenditure of time and money, and which, besides its other uses, is widely sold by it for repairing the bottoms of open-hearth steel furnaces, a purpose for which heretofore only imported Austrian magnesite could be used. It further averred that in the production of the article it has developed certain refinements of method which are and have been kept secret by the company and which constitute trade secrets of great value, as are also the cost accounts relating to the production of such article.

For further answer the company averred that the Navy Department ordered 250 tons of Syndolag, quoted by the company at $35 per ton, but the Department required the billing at $30 per ton; that under the order 64.9 tons were delivered, the contract being cancelled due to the signing of the armistice; that thereafter repeated demands were made by the Navy Department for affidavits showing cost of production of said article for the pretended reason of enabling the Navy to decide upon a price it would be willing to pay the company for the product; that it then offered, and still offers to accept any price for the material which the Navy may see fit to pay; that while the Navy's demands were being made it nevertheless paid for all the Syndolag delivered at the rate of $30 per ton; that it offers to return any part of such price or the whole thereof should the Navy be unwilling to fix such price; that regardless the Navy has made the demands without reason or just cause; that when the company refused finally to furnish such affidavits the Navy's demands were taken up with the Federal Trade Commission to obtain such through an assertion of its powers.

In view of these things Judge Orr, who tried the case, says it plainly appears that the Commission has undertaken to ascertain the cost of producing a product which is the subject of a patent, and to ascertain also the annual production thereof and the capital invested in its manufacture and the reasons therefor, as given in the company's answer, must be taken as true.

U. S. Has No Reserved Rights in a Patent

Then the court said that there was no reservation of right in the United States as against the inventor. The United States cannot appropriate or use the invention without just compensation in any different way than it can appropriate or use any other article owned by a private citizen.

Again it said the act of Congress under which the Commission proposed to investigate the cost of producing a patented product, in order that the Navy might acquire the same, does not in terms justify such proceeding. Instead, it said the act was aimed at unfair methods of competition in commerce, such commerce being confined to interstate and foreign commerce. The Commission more particularly relied upon section 6 of the act, in the present case, which appears to authorize proceedings without complaints being required to be served. The opening of that section is as follows:

Powers of the Commission

"That the Commission shall also have the power—

"(*a*) To gather and compile information concerning, and to investigate from time to time the organization, business, conduct, practices, and management of any corporation engaged in commerce, excepting banks and common carriers subject to the act to regulate commerce, and its relation to other corporations and to individuals, associations and partnerships."

Other subdivisions of section 6 are here given in substance:

"(*b*) The Commission may require detailed reports from such corporations under oath.

"(*c*) May investigate whether a final decree, intended to restrain any violation of the anti-trust acts, is being carried out, and upon application of the Attorney General are required to do so.

"(*d*) Upon direction of the President, or either house

of Congress, the Commission shall investigate alleged violation of the anti-trust acts by any corporation.

"(*e*) Upon the application of the Attorney General the Commission shall investigate and make recommendations for the readjustment of the business of any corporation alleged to be violating the anti-trust acts.

"(*f*) The Commission may make public information obtained, 'except trade secrets and names of customers,' and may submit recommendations to Congress for additional legislation.

"(*g*) May from time to time classify corporations and make rules and regulations for the purpose of carrying out the provisions of the act.

"(*h*) The Commission may investigate trade conditions in and with foreign countries."

Powers Claimed by Commission's Counsel

The court said it was plain that Congress intended to give the Commission a power unprecedented in its scope. The counsel contended that under the act the Commission was given the right to investigate any question having to do with any business of any corporation, except banks and common carriers subject to the control of the Interstate Commerce Commission, to conduct a hearing at any point in the United States, and compel there the attendance of any witnesses and the production of any records from any point in the United States.

But this argument, said the court, probably assumed that every corporation, with respect to which the Commission intended to conduct an investigation, was engaged in interstate commerce within the meaning of the act. And nowhere was it made to appear that the Basic Products Co. was engaged in interstate commerce in any other way than any other corporation or any citizen may be so engaged, by making one or more shipments of manufactured goods from one state to another.

Earlier Decisions Regarding Limitations of Power of Congress

Touching upon the limitations upon the power of Congress, and likewise upon the Commission in dealing with the activities of corporations or persons, an earlier decision was cited, wherein the court said:

"That neither the production or manufacture of articles or commodities which constitute subjects of commerce, and which are intended for trade and traffic with citizens of other states, nor the preparation for their transportation from the state where produced or manufactured, prior to the commencement of the actual transfer, or transmission thereof to another state, constitutes that interstate commerce which comes within the regulating power of Congress, and further, that after the termination of the transportation of commodities or articles of traffic from one state to another, and the mingling or merging thereof in the general mass of property in the state of destination, the sale, distribution, and consumption thereof in the latter state forms no part of interstate commerce."

The court then cited an opinion of the Supreme Court of the United States, discussing the lack of constitutional authority over industry (9 Sup. Ct., 10). Justice Lamar said in that case:

"Manufacture is transformation—the fashioning of raw materials into a change of form for use. The functions of commerce are different. The buying and selling and the transportation incidental thereto constitute commerce; and the regulation of commerce in the constitutional sense embraces the regulation at least of such transportation. . . . If it be held that the term includes the regulation of all such manufactures as are intended to be the subject of commercial transactions in the future, it is impossible to deny that it would also include all productive industries that contemplate the same thing. The result would be that Congress would be invested, to the exclusion of the states, with the power to regulate, not only manufactures, but also agriculture, horticulture, stock raising, domestic fisheries, mining—in short, every branch of human industry. For is there one of them that does not contemplate, more or less clearly, an interstate or foreign market? Does not the wheat grower of the Northwest, and the cotton planter of the South, plan, cultivate and harvest his crop with an eye on the prices of Liverpool, New York and Chicago? The power being vested in Congress and denied to the states, it would follow as an inevitable result that the duty would devolve on Congress to regulate all of these delicate, multiform, and vital interests—interests which in their nature are and must be local in all the details of their successful management. It is not necessary to enlarge on, but only to suggest, the impracticability of such a scheme, when we regard the multitudinous affairs involved, and the almost infinite variety of their minute details."

In the case against the Basic Products Co. its counsel contended that section 6 of the Trade Commission act was unconstitutional "in so far as it authorizes investigations and compulsory disclosures of matters which are beyond the commerce power of Congress," and also, "in so far as it attempts to authorize a search or seizure by an administrative agency of the Government without charge or suspicion of wrong doing," and urged upon the court the necessity of so declaring it. However, the court said that while this contention was probably sound, it was not necessary so to do in holding the Commission was without the power to carry on the investigation which it had assumed in the instant case.

Ruling of the Court

Says Judge Orr: "An incident of such investigation is the ascertainment of trade secrets. It is plain that the cost of manufacturing a patented product to which the manufacturer has the exclusive right may be a trade secret, a species of property of great value. This is also true of refinements of method in producing the same. The act prohibits the disclosure of trade secrets. The assumption that no such disclosure will be made disappears before the expressed intention to give the information to the Navy Department. We have then, a contemplated search and seizure, and a contemplated taking of private property for public use, without due process of law, which are violative of the Fourth and Fifth Amendments of the Constitution."

And on another point the court remarked: "It never was intended that the extent of a free man's duty to perform should be determined by those who demand performance."

Exports of Cement From United States

According to data compiled by the statistical division of the United States Bureau of Foreign and Domestic Commerce, the exports of domestic cement during the calendar year 1919 were 2,463,573 bbl., valued at $7,513,389.

Improved Apparatus for Determining Light Oil in Gas

By E. H. Bird

FOR some time the common method for the determination of light oil in coke-oven and illuminating gas has made use of a simple train of absorbing bottles. The method originally adopted by the Koppers Co.[1] specified a train of ten bottles. This has proved to be an efficient procedure and probably will always find use on account of the simplicity of the apparatus required. In a series of tests on this apparatus, when operated according to specifications, it was found to have an efficiency of 99 per cent.

For plant control tests, however, any such bottle train is objectionable on account of the excessive time and attention required to keep it in good order and to empty and refill it for each test. The oil-soaked stoppers easily slip out, the glass connections and bottles are easily broken and the rubber connections quickly wear out. For plant laboratories having regular light oil determinations to make, these are obvious disadvantages and there is too much opportunity for erroneous results due to some little carelessness in keeping the rubber parts renewed and in making the connections tight.

Double Coil Scrubber

The Koppers Co. laboratories undertook the problem of developing a more compact apparatus of adequate absorbing capacity. The work resulted in the invention of the "double coil scrubber,"[2] which has been in use in a number of laboratories for about two years. This apparatus is compact and substantial, having no glass parts, and is, at the same time, easily portable.[3] It provides for intimate contact between oil and gas, and may be emptied by turning a single valve, and refilled through a single opening.

Though designed for the absorption of light oil from coke-oven and illuminating gases, the apparatus may be used for the absorption of any constituent of a gas soluble in a liquid-absorbing medium, provided the absorbent will not attack the metal from which the apparatus is made. For instance, it is well adapted to the absorption of gasoline from natural or casinghead gas. A detachable cooling jacket provides for absorptions at temperatures other than atmospheric.

Design of Scrubber

The apparatus, as shown in Fig. 1, consists of two concentric vessels 13 and 14, made of sheet copper, each of which contains an absorbing coil shown at 4 and 8 respectively. The inner vessel 13 has an outlet pipe 10 at its lower end which is controlled by the valve 9 with handle 20. The outer vessel 14 has an outlet at the valve 12. The gas inlet pipe 1 leads downward into the inner vessel 13 and terminates in a jet 2, through which the gas passes into the coil 4. This jet is provided with an aspirator pipe 3, which forms the oil inlet of the coil. The inner chamber has a gas outlet which connects by a pipe 5 with a second jet 6, which connects with coil 8 and has aspirator pipe 7. The apparatus is filled with absorbing oil through the connection 16. The outlet gas connection from the apparatus is shown at 15. When it is desired to maintain the absorbing oil at other than atmospheric temperature, the apparatus can be jacketed. Fig. 2 shows the apparatus provided with a galvanized iron jacket and connected with a gas meter.

Operation of Apparatus

The valve handle 20 and the filling pipe 16 are opened and the valve 12 closed. About 3,000 c.c. of absorbing oil is poured into the chambers. This brings the oil level just below the outlets of each coil. The filling connection and the valve handle 20 are then closed, the inlet pipe 1 connected to the gas-sampling line and the outlet to a suitable gas meter. The gas is passed through the absorber at a definite rate, 2 cu.ft. per hr. being suitable for benzolized gas and 4 cu.ft. per hr. for debenzolized gas. The gas first passes through the inlet pipe 1 into the jet 2, from which it bubbles through the coil. In passing through this coil it is held in intimate and prolonged contact with the oil in the coil. The aspirator action of the jet is such as continually to draw fresh oil in through the aspirator pipe 3. The oil with which the gas comes in contact is expelled at the upper end of the coil. The gas then passes through the coil in the outer chamber in a similar manner and passes out to the meter. After the expiration of the absorption period the valve 9 is opened and the contents of both vessels drained from valve 12. The vessels will drain in a short time, but it is best to rinse out the apparatus by pouring in a little fresh oil in the opening 16 and shaking. The oil is then subjected to

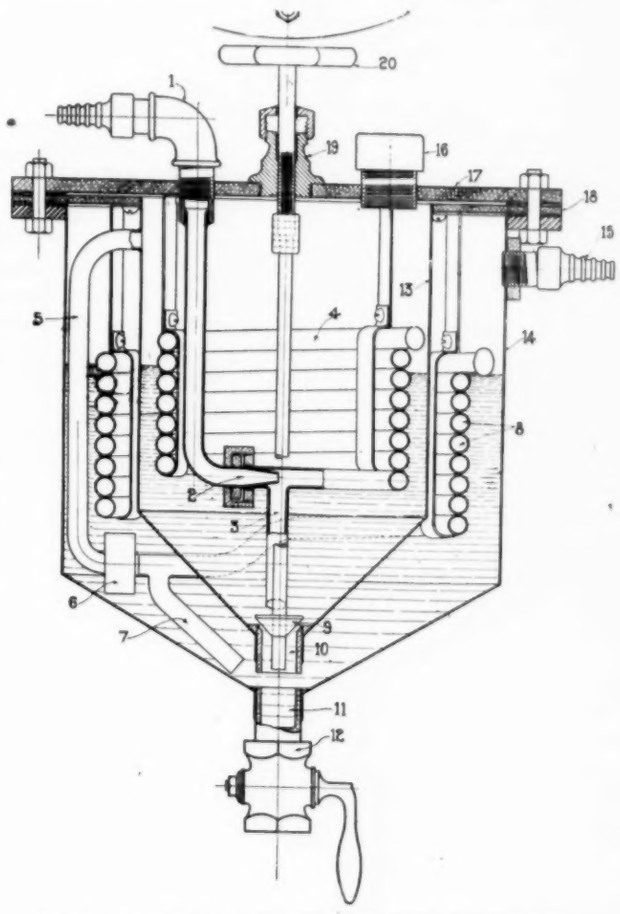

FIG. 1. SECTION OF DOUBLE COIL SCRUBBER

[1] F. W. Sperr, Jr., Met. & Chem. Eng., vol. 17, 1917, p. 550, of article entitled, "Laboratory Methods for Benzol Recovery," pp. 548-555; 586-588; 642-647.

[2] Patented by F. W. Sperr, Jr., and A. A. Kohr, U. S. No. 1,316,602.

[3] Weight of the apparatus without cooling jacket is 23 lb.

the standard steam distillation for the determination of the light oil.

The gas comes in good contact with the oil during the total length of the two coils, which is 20 ft. When the chambers are filled with the proper amounts of oil, about 70 per cent of it is contained in the outer vessel. As this is the last oil to wash the gas, the per cent enrichment does not rise so high as to cause inefficient absorption unless too large quantities of gas are scrubbed. The second chamber, in which the oil is kept separate from the first, is a necessary part of the apparatus, since no matter how thorough is the contact of oil and gas in the first chamber some light oil is lost. This loss is practically nothing at the start of the test, but increases with the enrichment of the oil. The much larger volume of oil in the outer chamber and the previous treatment in the inner chamber allow sufficient gas to be passed before appreciable losses begin to occur.

When the gas is passed through the absorber at a rate exceeding 6.5 cu.ft. per hr., a portion of the gas bubbles out of the aspirator pipes and therefore does not get as thorough contact with the gas as it should. A rate of 4 cu.ft. per hr. is recommended for testing debenzolized gas and 1 to 2 cu.ft. per hr. for benzolized gas. Five in. (water) of pressure is required to operate the apparatus unless suction is used.

This apparatus has been tested in the laboratory as follows: A measured amount of coke-oven light oil, all of which distilled under 200 deg. C., was vaporized uniformly into a current of air and passed through the absorber at a constant rate. A bottle train absorber was attached after the coil scrubber, and the light oil absorbed in this determined by the standard methods and the percentage not absorbed by the coil scrubber calculated. The whole apparatus was operated under suction in order that there should be no back pressure on the coil scrubber. The air was passed through a meter merely to keep the rate constant and to aid in vaporizing the light oil uniformly. One cu.ft. of air carried 1.5 c.c. of light oil (0.396 gal. per 1,000, imitating a coal gas rich in light oil). Three liters of absorbing oil were used in each test.

Efficiency

The efficiency of the apparatus was found to vary with the amount of light oil passed into it and with the rate of gas flow. In some cases, in order to get a measurable amount of light oil in the bottle train, fresh oil was put in the coil scrubber for two or three successive tests, the light oil in the bottle train only being determined after the last test of the series. The per cent enrichment of the oil in the two chambers of the absorber was also determined. On account of the much larger quantity of the oil in the outer chamber, the per cent enrichment is quite low until the oil in the first chamber is nearly saturated.

TESTS AT 2 CU.FT. PER HR.

Test Nos.	C.c. Light Oil Vaporized in Each Test	Per Cent Saturation Inner Chamber	Per Cent Saturation Outer Chamber	C.c. Light Oil in Bottle Train	Per Cent Efficiency of Coil Scrubber
1, 2 and 3	30	2.42	0.22	0.0	100.0
4 and 5	45	2.70	0.706	2.6	97.1
6 and 7	60	2.93	1.12	7.6	93.7

Obviously, the efficiency might also be determined by ascertaining the percentage of light oil absorbed. By such a method, however, the effects of distillation losses are undoubtedly exaggerated. For instance, a distillation loss of 3 per cent of the light oil absorbed in the scrubber would have a much greater effect on the efficiency figure than a distillation loss of 10 per cent of the light oil in the bottle train. Figures obtained for the efficiency of the apparatus by this second method will be given here for what they are worth. By means of blank tests, factors for distillation

FIG. 2. DOUBLE COIL SCRUBBER WITH COOLING JACKET AND CONNECTED WITH GAS METER

loss with different quantities of light oil were determined and applied in the use of this method. Even these corrections are somewhat uncertain on account of the exaggerated effect of small losses. After the application of these factors, the efficiency of the apparatus was found to be the following:

	Per Cent
Tests 1 to 3	98.2
Tests 4 and 5	96.0
Tests 6 and 7	90.0

Tests made at 4 cu.ft. per hr. showed the absorption to be less complete at that rate. When 45 c.c. of light oil was vaporized at that rate, an efficiency of 92.5 per cent was indicated.

It will be seen from the foregoing tests that in testing unscrubbed coal gas an absorption efficiency of practically 100 per cent should be obtained if an amount of gas is used containing about 30 c.c. of light oil. The efficiency with the gas volume containing 45 c.c. of light oil is 97 per cent, which is satisfactory for all plant control processes, and it is recommended that in testing unscrubbed gas the amount of light oil absorbed should not exceed 45 c.c. Tests on unscrubbed gas can be made at a rate of 2 cu.ft. per hr. Debenzolized gas can safely be run at 4 cu.ft. per hr.

The Koppers Co. Laboratories,
Mellon Institute, Pittsburgh, Pa.

Revival of Salt Industry at Inagua, Bahama Islands

American capital operating under the name of the Inagua Salt Co., Ltd., will be responsible for a revival of the salt industry of Inagua, Bahamas. The work is already under way and it is estimated that Inagua will soon be exporting 3,500,000 bushels of salt a year to the United States. The company proposes using several light-draught, three-masted auxiliary schooners for handling this export. Motor trucks and railway trucks will be employed for taking salt to shipping points.

Synopsis of Recent Chemical & Metallurgical Literature

Corrosion of Condenser Tubes.—The fifth report of the Corrosion Committee, presented by GUY D. BENGOUGH, R. M. JONES and RUTH PIRRET at the spring meeting of the Institute of Metals, is confined to the corrosion of condenser tubes (mainly 70:30 brass), and is a study of the practical problems of corrosion in condensers under service conditions, employing either sea water or fresh water. It is divided into four sections.

The first section deals with what has been called the diagnosis of condenser tube corrosion. The procedure to be followed in withdrawing and preparing a tube for examination is described, also the symptoms or appearances within the tube which correspond to each of the five main types into which the practical problems of corrosion under fresh-water or sea-water conditions have been classified. The importance of additional information concerning (*a*) the water supply and (*b*) the corroded tubes toward elucidating the cause of corrosion is shown and emphasized. This information, which is specified, has rarely been obtainable in the past, particularly as regards the water supply, and this may partly account for the lack of appreciation of the importance in corrosion troubles of the conditions existing within the plant. These conditions frequently vary very much from time to time, and it is shown that although the conditions which favor accelerated corrosion may be present for but short periods at irregular intervals, and consequently may not be easily detected, the effect on the tubes may still be very serious. Also in certain cases it is shown that accelerated, localized corrosion may persist after the initiating conditions have disappeared.

The second section is devoted to a consideration of certain features in the structure of condenser tubes, since an appreciation of these is of great value in following the mechanism of the types of corrosion studied later. Attention is principally directed to the presence on the tubes of a surface layer consisting of structureless and highly distorted metal. This layer has undoubtedly a greater resistance to corrosion by saline and fresh waters than the underlying crystalline metal, so that whenever this layer is penetrated corrosion will proceed at an increased rate. The layer has been stripped from a number of tubes of different composition. Its thickness is usually of the order of 0.01 mm., and indications have been obtained that its composition may be somewhat different from that of the underlying metal.

In the third section the five main types of brass condenser tube corrosion are considered separately in detail.

Type I. General Thinning.—This type may be considered as an accelerated form of the complete corrosion which normally occurs in saline solutions, in so far as the tube is gradually and uniformly reduced in thickness. The rate of ordinary complete corrosion is too slow to be of any serious consequence in practice; laboratory experiments with running sea-water have shown that a period of fifteen to twenty years may elapse (even presuming that the rate of corrosion is uniform and does not decrease with time) before a tube is reduced 50 per cent in thickness from this cause. Tubes almost always fail in practice by local action of some kind long before ordinary complete corrosion has seriously reduced the thickness of the tube. Rapid general thinning, however, is essentially a fresh-water phenomenon and is usually associated with the presence of free acid in the water supply. The results of tests on ten samples of tube of widely different composition in hydrochloric acid of concentration 3 parts in 100,000 at ordinary temperature show that in six weeks all tubes had lost from 2 to 4 per cent in thickness. That such a very dilute acid should reduce the thickness of a tube so much in such a short time at ordinary temperature is ample evidence of the serious effect of acid in the water supply upon the life of condenser tubes. Proper neutralization, preferably at the source of contamination, is an effective remedy for this trouble, but considerable difficulty may be experienced in detecting the acid, especially if, as is generally the case, it enters the water supply only intermittently. Regular and frequent tests of the water must be made when this type of trouble occurs.

Type II. Deposit Attack.—The principal cause of pitting which is the most frequent source of trouble in condensers is ascribed to what is termed "deposit attack." In the presence of sodium chloride solutions the cuprous oxide formed on a brass surface gradually changes to cuprous chloride. The latter is usually swept out of a condenser tube by the circulating water, but under various conditions may adhere at different parts of the tube surface. When such adherence has occurred, conditions now allow of the further gradual change of the insoluble cuprous chloride under the influence of oxygen to soluble cupric chloride and cuprous oxide. The action of cupric chloride solution on brass is very rapid, as may be gathered from the fact that a piece of brass tube 2 in. long, placed in a strong cupric chloride solution at ordinary temperature, was completely disintegrated and partially replaced by a pseudomorph in copper in two days. The action involves the oxidation of the copper and reduction of cupric chloride to cuprous chloride; redeposition of copper from solution by the zinc also occurs. In the presence of air cuprous chloride will again be converted to cupric chloride and the attack on the brass continued. Thus the action is both recurrent and local. Foreign bodies, and particularly colloidal bodies, lying in the tube have an injurious effect by serving as loci for the adhesion of cuprous chloride and by preventing the diffusion of cupric chloride. Observations on the incidence and distribution of pits in condenser tubes are shown to agree with the results which would be expected to follow from the above explanation of the mechanism of pitting. Attention is drawn to the importance of keeping tubes clean and as free as possible from foreign bodies as a means of preventing deposit attack.

Type III. Layer Dezincification.—An account is given, preliminary to the consideration of this type of corrosion, of the mechanism of so-called dezincification. The conclusion is reached that true parting of zinc and copper in a 70:30 brass does not occur but that the so-called residual copper is always redeposited copper. Dezincification is therefore only apparent and

not real, and the term is always subsequently employed by the authors in this sense.

The layer type of dezincification, which is characterized by disintegration of the brass tube and redeposition of copper over large areas, has been found to occur under both marine and fresh-water conditions. Several ways in which such action may occur are indicated. Under fresh-water conditions it is often associated with acid water, particularly if the acid is not too dilute and the access of oxygen is not very easy.

Type IV. Plug or Local Dezincification.—This type of local corrosion may be regarded as a form of deposit attack, as it always proceeds beneath a deposit and is stimulated by the presence of foreign bodies. It differs, however, in many ways from Type II. So far as is known it occurs only in sea water (or diluted sea water), and is always associated with adhering white salt consisting of colloidal zinc oxychloride (also containing some carbonate). It is readily reproducible in the laboratory, as it occurs spontaneously on the surface of 70:30 brass tubes after immersion in seawater at elevated temperatures (40 to 50 deg. C.) for a few days; and is hence rather more amenable to experimental study than the previous types of corrosion. It is shown that the production of the right concentration of zinc in the liquid layer adjacent to the corroding brass surface plays a large part in the formation of the characteristic white oxysalt, and that interference with the production of this condition, e.g. by lowering the zinc content of the brass or by raising the zinc content of the sea water, is sufficient to prevent its occurence. The dezincifying action is thought to be due to a small concentration of hydrochloric acid contained within the colloidal white salt. The difference in behavior of different batches of 70:30 tube—some always showing local dezincification, others never—persists after annealing or pickling, or both, and the reason for the difference in behavior is still not clear.

Type V. Water-Line Attack.—In the case of a brass tube only partially immersed in sea water, increased corrosion (compared to that of the immersed portion) takes place, not at the water-line as is commonly supposed, but above it, and sometimes as much as 2 cm. above the surface. Further, the attack is not uniform but is concentrated at areas where salt deposits have formed and is coterminous with the area covered by the deposits. Narrow bands of salt connect the seawater with the deposits. This type of corrosion is obviously a special form of deposit attack, taking place under the most favorable conditions inasmuch as the attack beneath the deposits is much more severe than in any of the previous types of corrosion. This type of attack may occur at the inlet end of condenser tubes when entangled air clings to the surface of the tube and is prevented by eddying effects from being swept away by the water-flow.

The fourth section of the report contains an account of preliminary work on the electrolytic protection of condenser tubes. The particular question investigated was that of the efficiency of electrolytic protection in preventing deposit attack, i.e. attack by cupric chloride solution. A piece of 70:30 brass tube made cathode to strip iron in a normal cupric chloride solution is very distinctly attacked, despite the small current passing from the solution to the brass. It is considered that an electric current slows down but does not necessarily inhibit corrosion of a cathode. By raising the current density sufficiently it is possible that all corrosion even in a cupric chloride solution may be prevented. Experiments have shown, however, that a current as large as 20 to 25 amp. per 1,000 sq.ft. is insufficient to prevent a 70:30 brass tube from being rapidly corroded by such a dilute solution of cupric chloride as a one-twenty-fifth normal solution. Some suggestions are made whereby the usefulness of the electrolytic protection process may be extended by special manipulation of it in the early part of the life of a tube, with the object of forming a thin continuous layer of calcium carbonate over the surface of the tube.

Recent Chemical & Metallurgical Patents

Complete specifications of any United States patents may be obtained by remitting 10c. each to the Commissioner of Patents, Washington, D. C.

Manufacture of Cement in Electric Furnace.—The ground constituent materials are introduced into an electric furnace the upper part of which consists of a vertical shaft while the lower part contains the electrodes. During their passage through the shaft, the materials are heated and are finally melted in the lower part of the furnace. The molten product is tapped at intervals and cooled suddenly by water or by air. (1,332,422; MAURICE L. BOILLOT and JEAN DAUDIGNAC of Moutiers, France; March 2, 1920.)

Solvent for Acetylene.—The use of cement in the mixture used as fillers for acetylene gas containers is desirable, but the free lime present in the cement reacts with the acetone in an objectionable manner. This difficulty may be avoided by adding to the acetone a quantity of ethyl acetate (or other ester of an organic acid) sufficient to react with the lime in the cement:

$$Ca(OH)_2 + 2CH_3COOC_2H = Ca(OCOCH_3)_2 + 2C_2H_5OH.$$

For example, the filler for a standard acetylene container such as is now used may be composed of:

Portland cement	8 lb. 8 oz.
Kieselguhr	8 lb. 8 oz.
Asbestos fiber	15 oz.
Water	28 lb.
Charcoal	1 cu.ft.

This mixture is introduced into the tank, allowed to harden and thoroughly dried. If the cement contains 1 per cent of free lime, i.e., 1.4 oz., about 3.5 oz. of ethyl acetate should be added to the acetone before adding this to the tank. (1,332,525; HENRY S. SMITH of New York and GEORGE O. CURME, JR., of Pittsburgh, Pa., assignors to the Prest-O-Lite Co., Inc.; March 2, 1920.)

Sulphur Retorts.—In these patents, two retorts somewhat resembling a Kelly filter press in design are described. They consist essentially of a cage into which the sulphur bearing rock is introduced and a housing into which the cage moves when charged. Steam is admitted and the cage rotated. The molten sulphur collects in the shell, from which it is discharged through a valve. (1,332,537; FRANK W. BECRAFT and ALBERT L. GENTER of Salt Lake City, Utah, and 1,332,542; WILLIAM E. CLIFFORD of Salt Lake City and THOMAS H. GREEN of Springfield, Ill.; both assigned to United Filters Corporation; March 2, 1920.)

Sodium Permanganate.—The oxidation of sodium manganate by means of chlorine is catalyzed by the addition of $Co(OH)_3$, which has the additional function of decomposing hypochlorites according to the equation:

$$2NaClO = 2NaCl + O_2$$

Thus, by using an excess of chlorine the free alkali present may be converted into sodium chloride. This prevents decomposition of the permanganate:

$$4NaMnO_4 + 4NaOH = O_2 + 2H_2O + 4Na_2MnO_4$$

Since the formation of hypochlorites and consequently of chlorates is prevented, the solution contains principally sodium permanganate and sodium chloride, which may be separated by crystallization. (1,330,032; ROBERT E. WILSON of Cambridge, Mass.; Feb. 3, 1920.)

Process of Concentrating Liquids.—It is possible to concentrate solutions without heating above 100 deg. F. by adding anhydrous sodium sulphate to the solution heated to the point of maximum solubility of sodium sulphate. Upon cooling crystals of the hydrated salt (Glauber's salt) separate and thus remove a considerable amount of water from the solution. Other anhydrous salts may be employed in the same manner. (1,330,016; GEORGE T. WALKER of Minneapolis, Minn., assignor to Colonial Chemical Co.; Feb. 3, 1920.)

Extracting Thorium From Monazite Sand.—The following procedure is suggested by OTTO N. BERNDT of Chicago: 500 lb. of monazite sand, which has been concentrated by means of a magnetic separator to remove ilmenite and other magnetic constituents and contains about 9 per cent thorium oxide, is treated with about 475 lb. of fuming sulphuric acid stronger than 66 deg. Bé., containing preferably about 5 per cent excess sulphur trioxide. The mixture is heated for a period sufficient to decompose the sands and to convert the thorium into an insoluble compound, the heating preferably being at such a rate that a temperature of 200 to 230 deg. C. is reached in between 3 to 4 hr. At this point the rise in temperature becomes more rapid, due probably to heat evolved by the reacting mass in substantial amounts, attaining a temperature of 300 to 350 deg. C. in from one-half to one hour. The reaction mass becomes greenish-yellow in color and is in stiff plastic state, capable of being further stirred. At this point external heating is stopped and the mass is permitted to cool for several hours while being stirred and is removed from the baking pot or digester. The product is a thick pasty mass weighing about 950 lb. The mass removed from the digesters is treated in suitable tanks with a sufficient quantity of water, preferably about 900 gal. for the above amount. A slight agitation of the solution which has a slight acidity will keep the insoluble thorium compound in suspension, while the heavier siliceous residues will settle to the bottom. The suspension of the thorium compound may be decanted and filtered, the thorium compound remaining as a residue on the filter in a greatly concentrated state and suitable for further purification. (1,329,747; assigned to Lindsay Light Co.; Feb. 3, 1920.)

Production of Cyanides.—This invention relates to an improved form of furnace for carrying out the fixation of nitrogen according to the Bucher process (U. S. Pat. 1,120,682; Dec. 15, 1914.) Briquets are formed of sodium carbonate, pulverized coke or charcoal and finely-divided iron. These are fed into a vertical retort and are treated counter-currently with nitrogen while heated to about 1,000 deg. C. As cyanide is formed, it fuses and binds the briquets together upon reaching the relatively cooler zone below the furnace. Here an eccentric rotating device breaks fragments from the bottom of the column. The broken material passes to a shallow cooler, from which it is delivered at a temperature but little above atmospheric. (1,329,721 and 1,329,722; WILLIAM D. MOUNT of Saltville, Va., assignor to Nitrogen Products Co.; Feb. 3, 1920.)

Cement From Low-Grade Carboniferous Material.—Certain materials such as oil shale, lignite and cannel coal can not be economically used as fuel because of the large amount of fixed carbon which is retained by the argillaceous ash. ROBERT W. LESLEY of Haverford, Pa., has found that this ash is a suitable material for the manufacture of portland cement in combination with calcareous or other ingredients. The carboniferous material is first destructively distilled in suitable retorts, ammonia and other valuable volatile products being recovered from the vapors. The fixed gases assist in heating the kiln referred to later. The ash from the retorts is mixed with limestone and subjected to a clinkering process in a gas or oil fired rotary cement kiln. The fixed carbon in the ash supplies a portion of the heat required in the operation. The hot gases from the kiln serve to heat the retorts for the distillation of further quantities of material. (1,323,294; Dec. 2, 1919.)

Dinitrochlorbenzene and Sulphur Black.—The nitrating agent employed is a mixture of 2,800 lb. H_2SO_4 (66 deg. Bé.) and 610 lb. $NaNO_3$. This is heated to 25 deg. C. in a jacketed cast-iron kettle and 400 lb. of chlorbenzene is added slowly, keeping the temperature between 45 and 50 deg. C. After the total quantity has been added the temperature is allowed to rise to 60 deg. C. The mixture is then heated to 115 to 120 deg. C. until nitration is complete. Upon pouring into water, the dinitrochlorbenzene separates. The product contains about 90 per cent of the 1.2.4 form and 10 per cent of the 1.2.6 form. It may be converted directly into sulphur black without first preparing dinitrophenol: 100 lb. of the product is heated with 500 lb. H_2O and 55 lb. NaOH, forming sodium dinitrophenate. A fused mixture of 210 lb. Na_2S crystals and 102 lb. S is then added and, after an hour, the mixture is heated under pressure for 12 hr. at 120 deg. C. The sulphur black is then precipitated by waste acid from the nitration step. (1,330,074; RICHARD HEYDER of Forest Hills, N. Y., assignor to Williamsburg Chemical Co., Inc.; Feb. 10, 1920.)

Silicon Carbide.—The formation of vapors of silica and silicon during the operation of a carborundum furnace results in an increase in the ratio of silica to carbon in the upper part of the furnace and the product is not uniform. OTIS HUTCHINS of Niagara Falls obtains a uniform product by using a mixture below the resistor core which contains proportionately more silica than that above the core. Thus, the lower portion may contain 100 parts C to 194 parts SiO_2, while the upper portion may contain 100 parts C to 170 parts SiO_2. (1,331,435; assigned to the Carborundum Co.; Feb. 17, 1920.)

Current Events
in the Chemical and Metallurgical Industries

The Shawinigan Industries

A joint meeting of the American Section of the Society of Chemical Industry with the New York Sections of the American Chemical Society and the American Electrochemical Society was held in Rumford Hall on Friday evening, April 9. Dr. H. W. Matheson, general manager, Canadian Electro Products Co., outlined the growth of one of the most interesting and promising electrochemical centers in America—Shawinigan Falls, Que.

Hydro-Electric Developments

Shawinigan Falls is on the St. Maurice River, about twenty-two miles north of the mouth of the river, and about equidistant from Montreal and Quebec. At Shawinigan Falls the river drops 150 ft. and is capable of developing about 250,000 hp. The Shawinigan Water & Power Co. installed two 5,000-hp. waterwheels and generators about 1900. In 1910 the plant had grown to 60,000 hp. and the present capacity is 200,000 hp., the latest installation being five direct-connected generating units, each complete with its double runner horizontal turbine, developing 20,000 hp. at the normal operating head of 150 ft. and a speed of 225 r.p.m.

The St. Maurice valley is one of the finest waterpower sites in the world. Two hundred miles above Shawinigan Falls, the great La Loutre dam (1,800 ft. long, 70 ft. high) impounds the headwaters of the river, forming a lake 360 square miles in area. When full, this reservoir contains enough water to generate one billion kw.-hr. in the existing hydro-electric plants, and thus serves to regulate the power output during periods of low water. Other hydro-electric plants are located at Grand' Mere and Gres Falls, so that the total power developed amounts to about 320,000 hp. at present, with 1,100,000 hp. estimated as the future capacity of the St. Maurice valley.

General Industrial Situation

Of the total power developed, 130,000 hp. is required by the chemical and electrochemical industries at Shawinigan Falls. Among the plants using large quantities of electric power may be mentioned:

The Northern Aluminum Co., which started in 1901 as the Pittsburgh Reduction Co., produces 60 tons of aluminum (pig, wire and cable) per day, using Louisiana bauxite. About 800 men are employed.

The Belgo Canadian Pulp & Paper Co. has a capacity of 165 tons of groundwood pulp, 100 tons of chemical pulp and 90 tons of paper per day.

The Canada Carbide Co. has a plant covering about fifteen acres. The furnaces require about 40,000 hp. and operate on three-phase, 30-cycle and three-phase, 60-cycle power, producing about 200 tons of calcium carbide per day. Coke is obtained from the Montreal Heat, Light & Power Co.

The Shawinigan Electro Metals Co. began operations in 1915 and is now producing magnesium in stick and powder form and is making a careful study of magnesium alloys.

The Canadian Carborundum Co. will soon require 20,000 hp. for the manufacture of carborundum, aloxite and ferrosilicon.

The Canadian Ferro-Alloys Co. uses 6,000 hp. in the preparation of ferrosilicon and ferrochrome.

The Canadian Electrode Co. supplies the other companies with amorphous carbon electrodes.

Acetone From Acetylene

The most interesting portion of Dr. Matheson's paper was devoted to the work of the Canadian Electro Products Co. in producing glacial acetic acid and acetone from acetylene. A brief résumé of the process will be found in Chemical and Metallurgical Engineering, vol. 21, Oct. 29-Nov. 5, 1919, p. 575, and a more detailed discussion will be published at an early date. The process may be divided into five stages:

1. Production of acetylene from calcium carbide.
2. Production of mercuric oxide from mercury.
3. Production of acetaldehyde from acetylene.
4. Oxidation of acetaldehyde to acetic acid.
5. Conversion of acetic acid into acetone.

In the production of acetylene, the carbide was allowed to drop upon aluminum plates in the generators, thereby preventing frictional sparks which might result in explosions. In regard to the second step, the speaker said that the electrolytic oxidation process for the preparation of mercuric oxide had been discarded but no details of the new process were given. Explosions in the brine condensers used in separating the acetic acid formed in step 4 were traced to peracetic acid which is formed at low temperatures in mixtures of air, acetaldehyde and acetic acid.

In conclusion, the speaker predicted a steady growth for Shawinigan Falls as an industrial center, since it can sell power in competition with any country in the world (not excepting Norway and Sweden), is free from labor agitations and is well located for export trade.

Mechanical Engineers' and Chemists' Meeting

On Thursday, April 29, the midcontinent section of the American Society of Mechanical Engineers and the Oklahoma section of the American Chemical Society will hold a joint meeting.

During the morning session the routine business of each section will be attended to and officers for the coming year will be elected. In the afternoon and evening a series of interesting papers will be presented. Among those who have prepared papers are: Dr. C. K. Francis, Cosden & Co., Tulsa; D. E. Foster, Foster & Gilmore, petroleum engineers, Tulsa; Prof. Fred W. Padgett, Oklahoma University, Norman; J. E. Stillwell, Empire Gas & Fuel Co., Bartlesville; Prof. Hilton I. Jones, Oklahoma University, Norman; Arthur Frank, consulting engineer, Tulsa; Mortimer E. Cooley, dean of College of Engineering, University of Michigan; Ernest Hartford, secretary of the A. S. M. E.

Amalgamation, With Special Reference to Steaming of Amalgamation Plates

At the Nov. 15, 1919, meeting of the Chemical, Metallurgical and Mining Society of South Africa a sub-committee consisting of S. H. Pearce and J. E. Thomas reported on the practice of steaming amalgamation plates. In order to get an authoritative opinion questionnaires were sent to all mill-manager members, and the answers, which were received from about half the members to whom questionnaires were sent, were used as a basis for the committee's remarks.

A diversity of opinion exists as to the desirability of steaming; some hold that because of the danger to the health of the workmen the practice should be prohibited, others that it is a necessary operation. The question resolves into one to be considered from the point of saving of labor and the health of the workmen.

Under certain conditions amalgam will accumulate on plates and its removal is laborious unless steam is used to soften the deposit. Depending upon its hardness, the deposit may be removed by scouring or may require the use of chisels. The conditions which affect the quantity and quality of the deposit of amalgam may be roughly divided into two classes, provided such deposits as are allowed to accumulate for the purpose of regulating output are excluded.

Factors Affecting the Class of Deposits

One class of deposits is due to the conditions of the plate—whether hard or soft—the grade or slope of the plate, the frequency of dressing. If a comparatively large amount of amalgam is left on the plate, more mercury can be used in dressing and the plate will remain soft and in good receptive condition longer than a comparatively bare plate under similar conditions. Such plates are scraped lightly and produce when steamed a large return. This method gives a high return by amalgamation with a minimum of labor but holds back gold. A similar condition of the plate may be obtained with the retention of a minimum amount of amalgam, but to obtain this result there are required more frequent dressing, hard scraping every day and probably also a thorough scouring every other day. This results in a high amalgamation return but requires a maximum of labor. Steaming would not be advocated under these conditions. A variation is found in less frequent scouring but in place of steaming a thorough monthly clean-up.

A second class of deposit is due to conditions over which the operator has little, if any, control. These include design of plant and peculiarities of the ore. In the case of a plant with launders of insufficient grade a high water-to-ore ratio is necessary and the plate area is unnecessarily large; on the other hand, modern plants with correct or probably excessive launder grade are economical in plate area. These conditions affect the grade of plate, 18 per cent being necessary in one case and 8 per cent in the latter. Apart from overcrowding of the plate areas, the steeper slope causes difficulty in control of plate condition. With a bare plate there is nothing to overcome the tendency of the mercury to run off the plate and it is necessary to choose between leaving a deposit on the plate and very frequent dressing. In either case the amalgam will harden more rapidly near the top of the plate and its removal will require more labor whether by steaming or by other means.

The degree of alkalinity of the mill water also affects plate accumulation in that an excess of lime hardens the amalgam. In some mills variation in the acidity of the rock make it difficult to regulate the alkalinity, and in these cases a scrape made in the usual way leaves a considerable quantity of amalgam, which may be removed by steaming. The fineness of the gold is also a minor factor. Coarse gold particles produce an amalgam that is easily removed, but the opposite is true where fine particles are present, and these if present in large proportion tend to produce an amalgam containing a higher percentage of gold and show a greater tendency toward accumulation.

Effect of Steaming Amalgamation

Dealing with the facts as they appear, the committee was of the opinion that steaming can be considered only as a means of saving labor, making it possible to remove plate accumulations with the least difficulty, as otherwise in the absence of a mechanical device a large amount of labor would be incurred in most instances.

As regards the effect of steaming amalgamation plates on the health of the workman, there is no doubt that, as with many other ailments, idiosyncracy plays a very large part and certain men suffer from some sort of indisposition after taking part in the operation. In many instances there is probability of mercurial affection, but in at least as many others it is equally probable that the indisposition is due to overexertion and poor health. It seems probable that the practice of eating meals with unwashed hands is far more dangerous as a means of conveying mercury into the system.

The precautions to be observed consist of:

Ample ventilation of plate-houses.

Exhaust steam from plates to be led outside of building.

Selecting men for the work who are known to be immune.

Division of the work to prevent overexertion.

Provision of wash basins, mouth washes, etc.

The report of the committee was followed by a discussion in which members and visitors took part. In the discussion additional points were brought out by those in favor of and opposed to the steaming of amalgamation plates.

List of Commercial Organizations in the United States

A revised edition of a publication that has proved to be a useful desk book among persons engaged in domestic trade has just been issued by the Bureau of Foreign and Domestic Commerce. It is designated Miscellaneous Series No. 99, "Commercial and Industrial Organizations of the United States," and supersedes the first edition issued in 1917. The publication gives the title and secretary's address of practically all active interstate, national, and international commercial organizations, classified both alphabetically and by industry. City commercial organizations are arranged by states, with the address of the secretary and data as to number of members, annual income, and date of annual meeting. The present edition is a complete revision in all particulars, only those associations which made reply to the Bureau's request for information being included.

Washburn's Testimony on Government Nitrogen

Charging that less than 1 per cent of the cost of fertilizer could possibly be given to the farmers as a benefit from operation of the Government plant, even if all the estimated saving could successfully be transferred to the ultimate price of fertilizer, Frank S. Washburn, president of the American Cyanamid Co., opposed before the Senate Committee on Agriculture the War Department's proposal to operate the cyanamide plant at Muscle Shoals. Mr. Washburn objected also to the proposal that the further financing of these plants be accomplished by selling sodium nitrate now held in reserve by the Government.

Criticism of Nitrate Program

Starting on the assumption that nitrates and ammonium compounds are not interchangeable sources of nitrogen for fertilizer or industrial chemical use, Mr. Washburn undertook to demonstrate that we had a large surplus capacity for ammonia production at the present time and that increase in this capacity as proposed for Muscle Shoals would only make it necessary to increase our dependence upon Chile for nitrates. He argued that every increase in the output of ammonia for fertilizer use must be accompanied by a corresponding increase in consumption of nitrates, since otherwise a properly balanced plant food will not be obtained. Mr. Washburn presented a very complete history of the nitrogen fixation developments in this country from the first work in 1907 at the Canadian cyanamide plant through the proposals made to the Government about the same time up to the Muscle Shoals hydro-electric company proposal in 1916. Various recommendations to the Ordnance Department and the Government's committees on nitrogen supply and other activities extending into the first six months of the war period were set forth at length in an attempt to discredit altogether the War Department policies. It was charged that work on the Haber process had resulted simply in wasting $13,000,000 without developing any successful plant or even a successful process. The cyanamide company had placed at the disposal of the War Department convincing evidence that this would be the result, but "the committee did not even accept the offer of the company of these proofs."

No Market for Cyanamide

Mr. Washburn claimed that the results from the cyanamide plant at Muscle Shoals had been 100 per cent satisfactory, the cheapness, purity of the product and capacity of the plant all being greater than expectations. He stated that if this plant had run three years under the contract and the agreements between the War Department and the Air Nitrates Corporation, the Government would have saved not only all of its costs and investment in the plant but a considerable sum in addition. On the other hand, the present result to the company after payment of taxes, losses, etc., is that there is nothing left. He denied that his company was interested in any negotiations to purchase this plant from the Government, as at the present time he believed that the real problem was how to find a market for the product from this plant. Cyanamide nitrogen, characterized as "the cheapest form of nitrogen," is available to the extent which the market now demands in this form, and operation of the Government plant throws upon the market an additional supply to the detriment of private interests, with no advantage to the Government.

Classifying the various sources and kinds of nitrogen for fertilizer supply, Mr. Washburn came to what he considers "the crux of the situation," which is the fact that ammonium sulphate cannot replace sodium nitrate in fertilizers. This is because only the nitrates are assimilated by the plants directly and the ammonia compounds must first be nitrified by bacterial action, which is very slow in the spring of the year when the benefit of fertilizer on plant growth is most important. He also claimed that in other industrial chemical uses the ammonium sulphate should not be regarded as in any sense a possible substitute or source for a substitute of nitrates.

With reference to the manufacture of nitrates at Muscle Shoals, he claimed that even if the plant was fully amortized and that no charge were made for power, yet it would not be a profitable proposition for the Government to continue operations there, as the market is not available for the product. He insisted that $38,000,000 more would have to be spent by the Government to complete the project at Muscle Shoals and that it was altogether out of the question to economically accomplish the additional development necessary under the War Department proposal with present costs.

Alternate Plan Proposed

Asked what alternate plan he proposed, he recommended that the plant be kept in condition ready for use in production of explosives in case of war, and that the Government hold itself in readiness to sell the plant to private interests whenever market conditions justified this. He insisted that no one would be willing to buy the plant at the present time but that the plant would probably not become obsolete in the near future, as the processes and equipment were already too fully standardized to permit this.

Estimated Requirements of Fixed Nitrogen

The charts which were presented to support the above conclusions were based upon projecting the normal increases in demand for nitrate and ammonia before the war up to 1930. For this latter year Mr. Washburn estimates a demand for 875,000 tons of sodium nitrate, 775,000 tons of ammonium sulphate or its equivalent in cyanamide and that surplus ammonia capacities would be available as follows: (*a*) assuming only a normal increase in pig iron production, 125,000 tons of ammonium sulphate surplus; (*b*) assuming that one-half the beehive ovens were converted to byproduct ovens an additional 165,000 tons of ammonium sulphate; (*c*) assuming full conversion from beehive to byproduct ovens a still further amount of 165,000 tons ammonium sulphate per year, and finally, (*d*) assuming that the Government Muscle Shoals plant is operated, 200,000 tons of ammonium sulphate additional surplus. The total demand and surplus thus estimated for 1930 are 2,325,000 tons computed as ammonium sulphate equivalent. Another chart estimated the world nitrogen resources in 1919 as 1,500,000 tons of nitrogen, of which about 900,000 tons finds ready market, the remainder being surplus capacity. This surplus capacity is shown by the charts as just equivalent to the sum of the capacities of the Haber and the cyanamide processes, which are given as 300,000 tons each per year. Projecting this curve to 1930, it was estimated that the demand for nitrogen in that year would amount to 1,280,000 tons of nitrogen, which is less than the present capacity for nitrogen production as estimated.

Portland, Oregon, a Shipping Point for Phosphate Rock

To facilitate the shipment of phosphate rock in bulk from the United States to Japan, Portland is erecting bunkers with a capacity of 20,000 tons, on its newest municipal terminals. These will be completed late in July or early in August. The new bunkers are to be equipped with mechanical conveyors for unloading the rock from the cars, in which it is brought from Idaho, into the storage bins. It is then loaded directly into ships for ocean transportation. The bunkers will be capable of loading a vessel of any size with a full cargo in one day.

Portland had an advantage over Seattle in a differential of one dollar in the rail rate from the producing center to the seacoast. The advantage of Portland over San Francisco lay in the fact that lumber is desired for shipment in part cargo lots with phosphate rock to balance the cargoes. As rock is exceedingly heavy, a vessel loaded with it alone would be down to the load line before all her cargo space was filled. It is held, therefore, that the ideal cargo is a combination of about 4,500 tons of rock and enough lumber to fill the hold. Lumber for export to the Orient is available at Portland in almost unlimited quantities.

Phosphate rock, consisting largely of calcium phosphate, is in great demand in Japan. Furukawa Co., Ltd., of Kobe, Japan, which has booked the largest amount to date for export, controls several large plants in Japan for crushing the rock and converting it into superphosphates.

Chemical Activities at Yale University

At present all the chemical work of the Academic Department and Sheffield Scientific School are consolidated under one head, thus doing away with much duplication of courses and equipment.

Plans are now under consideration to build a centrally located chemical laboratory to take care of the needs of the entire university. It is planned to build the new laboratory large enough so that all of the courses can be carried on under the same roof. Special emphasis will be given to the industrial side of chemistry, and the new laboratory will be well equipped for this purpose.

In order to further the work of organic chemistry in its application to the industries, a series of lectures by the following men has been arranged, for the students of this year: Dr. C. L. Reese, research director, E. I. du Pont de Nemours & Co.; Dr. C. G. Fink, head of research laboratory, Chile Exploration Co.; Dr. W. S. Landis, chief technologist, American Cyanamid Co.; Dr. Hyle, research director, Upjohn & Co., Kalamazoo, Mich.; Dr. C. R. Downs of The Barrett Co., Dr. C. O. John of the Bureau of Chemistry, Washington, D. C.

Exhibition of American Products in Buenos Aires

A cablegram from Commercial Attaché Julius Klein, at Buenos Aires, states that the American Chamber of Commerce in that city has requested the American National Expositions, Inc., to hold its proposed exhibition of American products in November and December of 1920 instead of March, 1921. This request has been agreed to, according to information received from the directors of American National Expositions, Inc.

War Department Releases Sodium Nitrate

An indication of the seriousness of the shortage of fertilizer raw materials was the action of the Senate on March 31 in allowing the immediate consideration and passage of a bill authorizing the Secretary of War to lend soda to fertilizer distributers or users. The rules of the Senate require that a resolution of that character must be referred to a committee. In this case the Committee on Agriculture had jurisdiction.

Quite contrary to custom the committee agreed immediately to report the bill favorably and the measure was passed without a dissenting vote. The text of the resolution is as follows:

> That in order to meet the existing emergency in the shortage of fertilizers, the Secretary of War is hereby authorized to turn over to agricultural fertilizer distributers, or users in this country, such quantity of nitrate of soda held as a reserve supply by the War Department as in his opinion can be spared consistently with the military needs of the Government, such stocks so turned over to be replaced by such fertilizer distributers or users with an equivalent amount of nitrate, the turning over and replacement being under such guarantees as the Secretary of War may prescribe.

The resolution had been approved prior to its introduction by both the War and Agricultural Departments.

Oil-Shale Plant to Locate at De Beque

The Shale Oil & Refining Co. of New York City has recently signed a contract with the Gas Machinery Co. of Ohio for the equipment of the first unit of a plant to produce gasoline from shale. The company has a large tract of oil-shale lands in Colorado, and is planning to erect its plant at De Beque, Col., to distill the shale. A contract is to be placed next month for a refinery.

The first unit will handle from 300 to 400 tons of shale per day which, it is estimated, will yield about 300 to 400 bbl. of oil. The Wallace process of distillation will be used, and eight retorts are to be installed. The plant is expected to be in operation about next September, and it is estimated that it will cost in the neighborhood of $250,000.

This is the first attempt to utilize the oil shales in this country on a commercial scale, and with the demand for oil ever on the increase this development will be watched with much interest.

Research on Alunite

The metallurgical research department of the Utah State School of Mines, in co-operation with the U. S. Bureau of Mines, has been doing considerable work recently on the massive low-grade alunite deposits from Piute County, Utah. Experiments have been made with the idea of economically obtaining potash from the ores by a simple roasting-lixiviation process. The object of the tests is to determine:

1. The roasting temperature best adapted to a high recovery of potash by subsequent lixiviation.
2. The size of crushed ore which on roasting at the most desirable temperature gives the best extraction-crushing economy combination.
3. Whether there is a loss of potash by volatilization during roasting operations.

Further tests on a large scale are now under way. These tests are to be carried on with the object in view of recovering the alumina as well as the potash.

Meeting of Electric Furnace Association

The Electric Furnace Association held a meeting at the Massachusetts Institute of Technology on April 8 at which the subject of adequately trained electric furnace operators was discussed. The symposium was led by Acheson Smith, president of the Association, who pointed out the tremendous growth of the electric steel industry, and the inability of steel producers to get a sufficient supply of trained electric furnace operators. The number of electric furnaces operating in the United States and Canada has increased from 22 in 1913 to 363 in 1920. The weight of electric steel castings has increased from 9,207 gross tons in 1913 to 108,296 gross tons in 1918. The following table shows the comparative production of crucible and electric steel in the United States and the growth of electric steel since 1913:

Year	Production of Steel Ingots and Castings by Crucible Process, Gross Tons	Electric Furnace, Gross Tons
1913	121,226	30,180
1914	89,869	24,009
1915	113,782	69,412
1916	129,692	168,918
1917	126,716	304,543
1918	115,112	511,364

The figures for alloy steels for the year 1918 may also be of interest:

Process	Ingots, Gross Tons	Castings, Gross Tons	Total, Gross Tons
Open hearth—basic	1,013,913	10,724	1,024,637
Open hearth—acid	323,913	29,191	353,104
Bessemer converter	41,286	23,430	64,716
Crucible steel	54,370	64	54,434
Electric steel	287,885	3,076	290,961
Total	1,721,367	66,485	1,787,852

"The possibility of using the electric furnace in the production of brass and other non-ferrous metals has just begun to be appreciated, and it is only recently that a considerable number of electric furnaces have been used in this field. At the beginning of 1919 there were possibly fifty-eight electric furnaces producing brass, while at the beginning of 1920 there were at least 146 electric furnaces engaged in this work. The results already accomplished indicate that the application of the electric furnace in this field has been highly successful and the demand for more furnaces will follow rapidly."

Demand for Skilled Melters

This great increase in the use of electric furnaces has led to an unsupplied demand for skilled melters and assistants. Discussion of Mr. Smith's paper developed the fact that colleges and universities could not be expected to supply this demand, for it is not their function to turn out men skilled in operating details. It appears to devolve on the electric-steel industry to train its own personnel from either technical graduates or intelligent skilled labor; or upon the manufacturers of electric furnaces to furnish service to the metal industries in the form of men trained by the manufacturers themselves. In the latter case the Electric Furnace Association might take official action in the establishment of a training school.

Officers Elected

Officers of the Association for the ensuing year were elected as follows: President, Acheson Smith; vice-presidents, C. H. Booth and H. L. Hess; secretary, C. G. Schluederberg; treasurer, F. J. Ryan; directors for two years, F. J. Tone and H. G. Weidenthal.

Personal

James Bradley, formerly of the Atlas Powder Co., is plant supervisor of the Du Pont dye and intermediate plant at Lodi, N. J.

Dr. Benjamin T. Brooks is chemical engineer for the Mathieson Alkali Works, with headquarters at the newly established New York office, 25 West 43rd St.

W. E. Burkhard, formerly chief chemist of the Baker-Adamson Co., is chemical engineer at the Perth Amboy Chemical Works.

A. S. Eastman has been placed in charge of chemical control at the Calco Chemical Co., Bound Brook, N. J.

Prof. Ralph H. McKee, of Columbia University, has been consulting with officials in Washington on various chemical matters.

Edwin Mullen, returning from the Army, has been made superintendent of the Camden Works, General Chemical Co.

Walter B. Murphy has been transferred from the Frankford plant of The Barrett Co. to the main offices in New York, where he will take up his new duties as manager of industrial relations.

H. C. Parmelee, editor of Chemical & Metallurgical Engineering, left New York April 7 for an extended trip. He attended the spring meeting of the American Electrochemical Society in Boston and is attending the meeting of the American Chemical Society in St. Louis, Mo. From there he will go west to Omaha, Denver, Salt Lake City and San Francisco. He expects to be gone about two months.

Dr. Charles L. Parsons, secretary of the American Chemical Society, will sail shortly for Europe. He expects to attend the meeting of the International Union of Pure and Applied Chemistry, which will be held in Rome in June. In addition he will visit a number of chemical plants in Italy, Switzerland, France, Belgium, Germany and England.

Charles F. Rand was elected chairman of the Engineering Foundation at a special meeting held March 25. He succeeds Dr. W. F. M. Goss, resigned.

W. Kilburn Scott was a recent caller at the nitrate division of the War Department in Washington.

Obituary

Arthur L. Ormay, illustrator-in-chief of the McGraw-Hill Co., died at his home in Brooklyn, March 23. Mr. Ormay was born in Hungary, May 25, 1881. After the usual preliminary education he entered the Polytechnic of Budapest, from which he was graduated in June, 1905, with the degree of M.E. He came to the United States the following year and shortly afterward joined the staff of *Engineering News* as draftsman and letterer. He stayed with this paper for about three years. He then went to John Hill with a proposal to establish a drafting department to do the work of the papers of the Hill group, which at that time consisted of the *American Machinist*, *Power*, and *Engineering and Mining Journal*. The consolidation of the McGraw and the Hill companies in 1917, after Mr. Hill's death, broadened Mr. Ormay's duties and responsibilities, as he then had ten technical papers to serve. He was given the title of illustrator-in-chief, which he held at the time of his death.

In addition to his other talents, Mr. Ormay was noted for his pen-and-ink sketches of persons. One of his best was a large likeness of Mr. Hill, which was finished shortly before Mr. Hill's death. This portrait displays an execution and artistic talent of a very unusual quality.

Current Market Reports

The Non-Ferrous Metal Market

New York, April 12, 1920—There have been few changes since last week.

	Cents per Lb.
Copper, electrolytic	19.25
Aluminum, 98 to 99 per cent	32@33
Antimony, wholesale lots	11.25
Nickel, ordinary	43.00
Nickel, electrolytic	45.00
Tin, Straits, spot	62.25
Lead, New York, spot	9.00
Lead, E. St. Louis, spot	8.75
Zinc, spot, New York	9.00
Zinc, spot, E. St. Louis	8.60

OTHER METALS		
Silver	oz.	$1.26
Cadmium	lb.	1.40@1.50
Bismuth (500 lb. lots)	lb.	2.50
Cobalt	lb.	1.50
Magnesium (f.o.b. Niagara Falls)	lb.	1.60
Platinum	oz.	142.00
Iridium	oz.	250.00
Palladium	oz.	142.00
Mercury	75 lb.	103.00

FINISHED METAL PRODUCTS	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	29.50
Copper sheets, cold rolled, (over 14 oz.)	31.50
Copper bottoms	38.00
Copper rods	26.75
High brass wire and sheets	26.50
High brass rods	23.75
Low brass wire and sheets	27.25
Low brass rods	28.00
Brazed brass tubing	37.00
Brazed bronze tubing	41.75
Seamless copper tubing	34.00
Seamless bronze tubing	34.50
Seamless high brass tubing	33.00

SCRAP METALS	Cents per Lb. Buying Price
Aluminum, cast scrap	22.00@23.00
Aluminum, sheet scrap	21.50@22.75
Aluminum clippings	24.75@26.00
Copper, heavy machinery comp.	14.25@14.75
Copper, heavy and wire	14.25@14.50
Copper, light and bottoms	13.00@13.50
Copper, heavy cut and crucible	15.50@15.75
Brass, heavy	9.50@10.00
Brass, casting	9.00@9.25
Brass, light	9.00@9.25
No. 1 clean brass turnings	8.75@9.25
No. 1 comp. turnings	11.25@11.50
Lead, tea	5.75@6.00
Lead, heavy	7.75@8.00
Zinc, scrap	5.25@5.75

The Iron and Steel Market

Pittsburgh, Pa., April 9, 1920.

The outstanding feature of the iron and steel market situation is the wide variety of opinions held by those in the trade both as to the actual condition today and as to the prospects. The condition as to production, which is large, is held in some quarters to indicate that prices must decline, and in other quarters to prove that steel will be still scarcer when expected additional demand develops. As to the future, not merely of steel but of industry generally, there are those who predict a "panic," though precisely what is meant by the term is not defined, next August or September, there are others who predict something of the sort a year hence, or some time in 1921, and still others who insist there is no basis for predicting any panic at all, except that if one lives long enough he is likely to see almost anything.

The monthly steel ingot report of the American Iron and Steel Institute shows that in March 3,296,799 gross tons of steel ingots were produced by thirty companies which in 1918 made 84.03 per cent of the country's total. Counting the number of working days in the month and year and allowing for the producers not reporting, this indicates that during March steel ingots were produced at the rate of 45,200,000 tons per annum. Similarly indicated rates were 44,200,000 tons in February and 40,650.000 tons in January. For the last four months of 1919 no monthly reports were made. Even the January output was larger than had been expected in December, and the increase from January to March was 11 per cent.

The manufacturing difficulties that were foreseen in December—shortage of coke and coal, winter weather, etc.—were all experienced, and the works probably did not operate at much higher percentages of their capacity than had been expected, but it now appears that capacity of the industry as a whole was underrated, and this means that the March production rate can be improved upon very materially. Until quite recently the country's steel ingot capacity was regarded as being 49,000,000 to 50,000,000 tons, according to estimates quite generally accepted. On this basis, however, the March production, with all the obstacles to efficient operation, would be more than 90 per cent of capacity. The disposition now is to regard capacity, under favorable working conditions, as nearer 55,000,000 tons. On a 55,000,000-ton rating the March output would be 82 per per cent of capacity, and that seems to be too low a percentage, in view of the conditions, just as 90 per cent seems too high.

Outlook Good for Fullest Employment of Steel Mills

Shipments of finished steel products from mills were slightly in excess of the production, as a little progress was made toward reducing the large accumulations of January and February caused by car shortage. Receipts by consumers were in turn heavier than shipments, because belated shipments were arriving. Thus the receipts of steel were very large indeed. All the surface indications are that the steel was all absorbed and passed into actual ultimate consumption. If that really was the case, there are very strong probabilities that steel will be as scarce in future as of late, if not scarcer, for it was common everyday consumption that absorbed the great bulk of the steel. Very little steel went to railroads and relatively little went into large construction works. In future it is quite certain the railroads must have much more steel, and certainly there will be much more steel, eventually, consumed in construction work. From this viewpoint the outlook is for the fullest employment of steel mills for a long time to come, and for the minimum prices now asked, those of the Steel Corporation, to rise, even though the maximum prices, now secured for early deliveries, may fall part of the distance by which they are separated from the minimum prices.

The experience of a few weeks, however, can hardly be accepted as sufficient to prove the case, especially when the case is such an important one. When steel was so extremely scarce for several months, a few weeks of heavy shipments without a surplus becoming visible is hardly a sufficiently long experiment. It is said that jobbers and manufacturing consumers have up to date accumulated no stocks, but there has hardly been time for a trustworthy canvass to be made, if indeed trustworthy information could be secured in all quarters. Nor would the absence of stocks in the hands of manufacturing consumers prove the entire case. Many of them make goods that are in turn handled by jobbers and retailers, whose stocks likewise have been low and may be in process now of being built up. The household, the carpenter's shop, the contractor's history, may have been getting material long desired.

In view of these considerations there are those in the steel trade who now argue that when so much steel can be made, and is being pushed out into business, a relaxation in the pressure of buyers will quite possibly occur at an earlier time than the broader demands, of railroads and investment builders, are expressed in actual orders. The one might occur in a few weeks, the other might not come for months, perhaps not until next year.

The American Sheet & Tin Plate Co. announces that early next week, presumably about Tuesday, it will open its order books for second half business in the case of manufacturing consumers and third quarter in the case of jobbers, at the following prices: Blue annealed sheets, 10 gage, 3.55c.; black sheets, 28 gage, 4.35c.; galvanized sheets, 28 gage, 5.70c.; 100-lb. tin plate, $7 per base box, Pittsburgh, plus rail freight to destination. These are the prices in the Industrial Board schedule that became effective March 21, 1919. The Steel Corporation subsidiaries have adhered to that price schedule in all particulars, and a fresh evidence is now afforded, though none was needed, that the

corporation has no intention of departing from its well-known policy as to prices.

As was the case with contracts for the present half year, the independent tin plate manufacturers in general will probably sell at the $7 price. The independent sheet manufacturers, with perhaps an occasional exception, now show no disposition whatever to observe the Steel Corporation prices. They have been selling up to date at a variety of prices, depending upon tonnage, time of delivery and the standing with the producer of the buyer. With nearly all mills the regular customer gets a lower price than the casual or chance buyer. Roughly speaking, prices of independent sheet manufacturers run from ½c. a lb. to 3c. or 4c. a lb. above the basis prices. The independents will sell only short distances ahead, as formerly.

Pig Iron

Substantially all the Connellsville furnace coke available for April has been disposed of, either by direct sales or by price adjustment under contracts calling for a monthly settlement. Except for two or three early transactions the coke has brought $11@$12, the Government limit ruling to the end of March having been $6. The high coke market has served to stiffen the position of merchant furnaces, but at the same time there has been little demand for pig iron. The valley market is quotable steady but quiet at former figures: bessemer, $42; basic, $41.50; foundry, $42, f.o.b. valley furnaces, freight to Pittsburgh being $1.40.

Ferro-Alloys

Ferromanganese for second quarter is firm at a minimum of $180, delivered, some producers quoting $200, while early deliveries command up to about $250. English is quoted at $200, c.i.f. Spiegeleisen continues to stiffen, being now quotable at $62 to $62.50, furnace, for spot, 19 to 21 per cent. Electrolyic ferrosilicon is held at $80, delivered, for 50 per cent and at $140 for 75 per cent. Bessemer ferrosilicon quotations are unchanged at $59.50 for 10 per cent, $62.80 for 11 per cent and $66.10 for 12 per cent, f.o.b. furnaces at New Straitsville and Jackson, Ohio.

The Chemical and Allied Industrial Markets

New York, April 12, 1920.

The tendency of these markets continues upward, especially in the alkalis and heavy chemicals. The coal-tar products are generally firm, owing to the scarcity of material in practically all lines. The present dock strike has crippled the spot market, which even before this trouble was in a bad way. No decline is foreseen for some time to come, particularly with the shortage of steel containers and the poor transportation facilities to be faced. This does not imply that if these conditions were more ideal the situation would be easier, for producers are unable to get the same percentage of production out of the same materials as they were formerly and output has fallen far behind the demand. The cost of labor alone in the production of most of the listed chemicals would be almost sufficient to maintain the present price levels.

PRINCIPAL PRICE CHANGES

	Today	Last Week	Last Month	Last Year
Alcohol, methyl	$3.50	$3.50	$2.50	$1.50
Barium chloride	180–200	140–150	160–170	70–80
Soda ash, light	2.75	2.50	2.50	1.50
Soda ash, dense	3.00	2.75	2.75	2.25
Sodium hydroxide	6.00	6.50	5.25	2.50
Sodium nitrite	.27	.30	.60	.17

General Chemicals

Under pressure of heavy demand and small supplies *alum*, *ammonia lump*, has been well sustained at 4@5c. per lb., while *potash lump* is fairly active at 7½@8½c. per lb. on contract. There were some small quantities of *ammonium sulphate* being sold on back contracts at 6c. per lb., but these have been filled and the present quotation ranges from 7@8c. Both grades of *sal ammoniac* remain practically nominal, as there is no material available on the spot market at present. *Oxalic*, crystals, has come up, being listed at 44@45c. per lb. for future and as high as 48c. is being asked for spot material. Stocks on this item are not dangerously low, but producers are having difficulty in keeping up with the present brisk demand. *Barium chloride* is tighter than it has been since the rapid rise of a week ago. Some material is changing hands in small lots and prices as high as $200 per ton are being asked for spot. A shipment is expected to arrive in this market soon, which ought to break the present high level. The Association price on *caustic soda* has been raised again recently to $4.50@$5.50 per cwt. But this is no indication of the market, as business is being transacted on a $6@$6.50 basis, with even higher prices reported for spot material. *Sodium nitrite* has come up again slightly and is now listed at 33@35c. per lb. for spot material. One large handler of this item is awaiting the arrival of a shipment and will sell at 22c. per lb. *Soda ash* is practically off the market, as there is no material to be had on the spot market and producers are so far behind in their contracts they cannot take any more business at present. Prices are nominal at $3.25@$3.50 per cwt. It is reported that manufacturers are sold out and refuse to quote on *sodium sulphide*, 60-62 per cent fused, prices ranging from 7@7½c. for future and 8@8½c. per lb. for spot, are nominal. The brisk demand on *copperas* has nearly exhausted the market of this item, and producers are unable to meet the demand. Quotations of $1.50@$2 per cwt. are practically nominal.

Coal-Tar Products

This market remains practically unchanged, prices being sustained in all lines by scarcity of material. Demand is heavy and producers are unable to take care of all the business and are falling behind in their contracts. Spot market activity is confined to the scarcer items on the list, with only small quantities changing hands at extreme prices. To add to this the material in the hands of dealers is nearly exhausted and according to those engaged in this line there is no relief in sight.

Cresylic acid, 97-99 per cent, held firm at the former high level of 95c.@$1.10, while 50 per cent is still listed at 60@70c. per gal. *H* acid is still unobtainable except in small lots which are being sold as high as $1.90@$2 per lb. There is very little *napththionic* acid, crude, to be had. Prices are firm at the former levels of 65@85c. per lb. *Dimethylaniline* is still off the market. No quotations were heard, as there is no material being offered. *Nitrobenzol* is nominally listed at 14@19c. per lb., but there is very little material available at these prices and producers are completely sold out. *Paratoluidine* is in the same position, spot prices ranging from $2@$2.50 per lb.

Waxes

This market is in practically the same position as it was a week ago. Interest has fallen off slightly in refined *beeswax*, dark, which dropped from 39@40c. to 38@39c. per lb. Large supplies of Japan grade are reported in the primary market, but buyers seem fairly supplied, a condition that has held this grade in the same position as was previously reported, 19@20c. per lb. being the quotation received.

Crude Rubber

The recent jump in exchange has steadied this market to some extent. Dropping prices have stopped and quotations remain at the levels previously reported. As yet buyers have not come back into the market due to a large extent to difficulty in obtaining tire fabric, which has considerably restricted the output of this industry. *Plantation* grades are listed as follows: *First latex*, 47½@48½c.; *brown crepe*, thin clean, 45c., and ribbed smoked sheets, 37@48c. per lb., with little trading in sight.

Vegetable Oils

This market has been generally weak during the period, there being very little activity evidenced. ***Linseed oil***, raw, in car lots, came up from $1.74 of a week ago to $1.84, while boiled, in car lots, is listed at $1.87 per gal. for May and June. Prices ranging from $1.65@$1.70 for July-December delivery have been heard during the period. Other oils have been quiet, prices remaining firm with very little actual business transacted.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	—	$0.60 – $0.65
Acetone	lb.	$0.13 – $0.15	.16 – .18
Acid, acetic, 28 per cent	cwt.	3.50 – 4.00	4.25 – 4.50
Acetic, 56 per cent	cwt.	8.00 – 8.25	8.25 – 8.50
Acetic, glacial, 99½ per cent, carboy	cwt.	12.00 – 14.00	16.50 – 17.50
Boric, crystals	lb.	.14½ – .15½	.15½ – .16½
Boric, powder	lb.	.14½ – .15	.15 – .16
Citric	lb.	.85 – .86	1.17 – 1.18
Hydrochloric	lb.	.08 – —	.09 – .10
Hydrofluoric, 52 per cent	lb.	.12 – .12½	.14 – —
Lactic, 44 per cent tech	lb.	.11 – .11½	.12 – .16
Lactic, 22 per cent tech	lb.	.04½ – .05	.05½ – .07
Molybdic, C. P.	lb.	—	4.25 – 5.00
Nitric, 40 deg.	lb.	.07 – .07¼	.07½ – .08½
Nitric, 42 deg.	lb.	.07½ – .08	.08½ – .09¼
Oxalic, crystals	lb.	.44 – .45	.46 – .48
Phosphoric, Ortho, 50 per cent solution	lb.	.24 – —	— —
Picric	lb.	.30 – .35	.40 – .50
Pyrogallic, resublimed	lb.	2.50 – 2.55	2.60 – 2.65
Sulphuric, 60 deg., tank cars	ton	16.00 – 18.00	— —
Sulphuric, 60 deg., drums	ton	—	— —
Sulphuric, 66 deg., tank cars	ton	22.00 – 25.00	— —
Sulphuric, 66 deg., drums	ton	32.00 – 33.00	— —
Sulphuric, 66 deg., carboys	ton	34.00 – 35.00	— —
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 – 30.00	32.00 – —
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 – 30.00	34.00 – —
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 – 35.00	40.00 – —
Tannic, U. S. P.	lb.	—	1.35 – 1.45
Tannic (tech.)	lb.	—	.60 – .80
Tartaric, crystals	lb.	—	.69 – .74
Tungstic, per lb. of WO	lb.	—	1.20 – 1.40
Alcohol, Ethyl (nominal)	gal.	5.10 – 5.50	6.00 – 7.00
Alcohol, Methyl (nominal)	gal.	2.35 – 3.50	— —
Alcohol, denatured, 188 proof (nominal)	gal.	—	1.00 – 1.05
Alcohol, denatured, 190 proof (nominal)	gal.	—	.98 – 1.02
Alum, ammonia lump	lb.	.04 – .05	.05¼ – .06
Alum, potash lump	lb.	.07½ – .08¼	.09 – .09½
Alum, chrome lump	lb.	.15 – .16	.18 – .20
Aluminum sulphate, commercial	lb.	.01½ – .02	.02½ – .03½
Aluminum sulphate, iron free	lb.	.02½ – .03	.03¼ – .03¾
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½ – .10¾	.11 – .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.33 – .35	.35 – .37
Ammonium carbonate, powder	lb.	.16 – .16½	.17 – .17½
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.15½ – .16½	.17 – .18
Ammonium chloride, granular (gray salammoniac)	lb.	.13 – .13½	.14 – .14½
Ammonium nitrate	lb.	.10 – .12	— —
Ammonium sulphate	lb.	.07 – .08	.08½ – —
Amylacetate	gal.	—	3.65 – 3.75
Arsenic, oxide, lumps (white arsenic)	lb.	—	.10½ – .11
Arsenic, sulphide, powdered (red arsenic)	lb.	.23 – .24	— —
Barium chloride (nominal)	ton	125.00 – 135.00	180.00 – 200.00
Barium dioxide (peroxide)	lb.	.23 – .27	.28 – .30
Barium nitrate	lb.	.17 – .19	.20 – .22
Barium sulphate (precip.) (blanc fixe)	lb.	.03 – .03½	.05½ – .06
Bleaching powder (see calcium hypochlorite)		—	— —
Blue vitriol (see copper sulphate)		—	— —
Borax (see sodium borate)		—	— —
Brimstone (see sulphur, roll)		—	— —
Bromine	lb.	.85 – .90	— —
Calcium acetate	cwt.	2.00 – 2.05	2.10 – —
Calcium carbide	lb.	.05 – .06	.06½ – .07
Calcium chloride, fused, lump	ton	22.00 – 25.00	30.00 – 40.00
Calcium chloride, granulated	lb.	.01½ – .01¾	.02 – .02½
Calcium hypochlorite (bleaching powder)	cwt.	4.00 – 4.25	4.35 – 4.50
Calcium peroxide	lb.	—	1.50 – 1.70
Calcium phosphate, monobasic	lb.	—	.75 – .80
Calcium sulphate, pure	lb.	—	.25 – .30
Carbon bisulphide	lb.	.07 – .08	.09 – .10
Carbon tetrachloride, drums	lb.	.11 – .11½	.12 – .15½
Carbonyl chloride (phosgene)	lb.	—	.80 – 1.05
Caustic potash (see potassium hydroxide)		—	— —
Caustic soda (see sodium hydroxide)		—	— —
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.06 – .07	.08 – .09
Chloroform	lb.	.29 – .30	.31 – .32
Cobalt oxide	lb.	—	2.00 – 2.05
Copperas (see iron sulphate)		—	— —
Copper carbonate, green precipitate	lb.	.27 – .28	.29 – .31
Copper cyanide	lb.	—	.65 – .70
Copper sulphate, crystals	lb.	.08¼ – .09	.09 – .09¼
Cream of tartar (see potassium bitartrate)		—	— —
Epsom salt (see magnesium sulphate)		—	— —
Formaldehyde, 40 per cent (nominal)	lb.	.38 – .40	.60 – .80
Glauber's salt (see sodium sulphate)		—	— —
Glycerine	lb.	—	.24½ – .26
Iodine, resublimed	lb.	—	4.10 – 4.30
Iron oxide, red	lb.	—	.03 – .20
Iron sulphate (copperas)	cwt.	1.50 – 1.75	1.80 – 2.00
Lead acetate, normal	lb.	.14 – .14½	.15 – .18
Lead arsenate (paste)	lb.	.11 – .12	.13 – .17
Lead nitrate, crystals	lb.	—	.90 – 1.00
Litharge	lb.	.14 – .15	.15½ – .16
Lithium carbonate	lb.	—	1.50 – —
Magnesium carbonate, technical	lb.	—	.13 – .14½
Magnesium sulphate, U. S. P.	100 lb.	3.40 – 3.55	3.60 – 4.25
Magnesium sulphate, commercial	100 lb.	3.00 – 3.10	3.10 – 3.25
Nickel salt, double	lb.	.14 – —	.15 – —
Nickel salt, single	lb.	.16 – .17	.17½ – —
Phosgene (see carbonyl chloride)		—	— —
Phosphorus, red	lb.	—	.60 – .65
Phosphorus, yellow	lb.	—	.35 – .37
Potassium bichromate	lb.	.36 – .37	.38 – .42
Potassium bitartrate (cream of Tartar)	lb.	—	.56 – .60
Potassium bromide, granular	lb.	—	.50 – .65
Potassium carbonate, U. S. P.	lb.	.60 – —	.65 – .70
Potassium carbonate, crude	lb.	.21 – .25	.28 – .30
Potassium chlorate, crystals	lb.	.15 – .16	.21 – —
Potassium hydroxide (caustic potash)	lb.	.28 – .29	.30 – .35
Potassium iodide	lb.	—	3.35 – 3.60
Potassium nitrate	lb.	.19 – —	.21 – —
Potassium permanganate	lb.	—	$0.65 – $0.95
Potassium prussiate, red	lb.	1.00 – 1.05	1.10 – 1.20
Potassium prussiate, yellow	lb.	.34 – .36	.38 – .41
Potassium sulphate	ton	$225.00 – 240.00	— —
Rochelle salts (see sodium potas. tartrate)		—	— —
Salammoniac (see ammonium chloride)		—	— —
Sal soda (see sodium carbonate)		—	— —
Salt cake	ton	22.00 – 26.00	— —
Silver cyanide (nominal)	oz.	—	1.25 – —
Silver nitrate (nominal)	oz.	—	.77 – 82½
Soda ash, light	100 lb.	2.75 – —	3.50 – 3.60
Soda ash, dense	100 lb.	2.90 – 3.25	3.55 – 3.65
Sodium acetate	lb.	.06½ – .07	.07 – .08
Sodium bicarbonate	100 lb.	2.40 – —	2.75 – 3.00
Sodium bichromate	lb.	.33 – .34	.35 – .40
Sodium bisulphate (nitre cake)	ton	7.00 – 7.50	8.00 – 10.00
Sodium bisulphite Powered	lb.	.05½ – .06½	.07 – .07½
Sodium borate (borax)	lb.	.08½ – .08¾	.09 – .09½
Sodium carbonate (sal soda)	100 lb.	1.60 – 1.80	1.80 – 2.00
Sodium chlorate	lb.	.10 – —	.12 – .14
Sodium cyanide, 96-98 per cent	lb.	.24 – .25	.26 – .27
Sodium fluoride	lb.	.14 – —	.15 – .16
Sodium hydroxide (caustic soda)	100 lb.	4.50 – 5.50	6.00 – 6.50
Sodium hyposulphite	lb.	—	.03 – .04
Sodium molybdate	lb.	2.50 – —	3.25¾ – —
Sodium nitrate	100 lb.	3.00 – 3.25	3.75 – 4.00
Sodium nitrite	lb.	.26 – .27	.33 – .35
Sodium peroxide, powdered	lb.	—	.30 – .32
Sodium phosphate, dibasic	lb.	.03¾ – .04½	.04½ – .05
Sodium potassium tartrate (Rochelle salts)	lb.	.39 – .40	.40 – .41
Sodium prussiate, yellow	lb.	.23 – .z	.30 – .40
Sodium silicate, solution (40 deg.)	lb.	.01½ – .02	.02 – .02½
Sodium silicate, solution (60 deg.)	lb.	.02½ – .03	.04 – .05
Sodium sulphate, crystals (Glauber's salt)	cwt.	1.15 – 1.40	1.60 – 2.00
Sodium sulphide, crystal, 60–62 per cent (cone)	lb.	.07 – .07½	.08 – .08½
Sodium sulphite, crystals	lb.	.03½ – —	.04 – .06
Strontium nitrate, crystals	lb.	.25 – —	.28 – —
Sulphur chloride	lb.	.05¾ – —	.06 – —
Sulphur, crude	ton	22.00 – —	— —
Sulphur dioxide, liquid, cylinders	lb.	.09 – —	.10 – .12
Sulphur (sublimed), flour	100 lb.	3.35 – —	3.40 – 3.65
Sulphur, roll (brimstone)	100 lb.	3.20 – —	3.30 – 3.40
Tin bichloride (stannous)	lb.	.42½ – —	.46 – .50
Tin oxide	lb.	.50 – .60	.65 – —
Zinc carbonate, precipitate	lb.	—	.19 – .20
Zinc chloride, gran.	lb.	.13 – —	.13½ – .15
Zinc cyanide	lb.	.49 – —	.50 – .60
Zinc dust	lb.	.11½ – .12½	.13 – .15
Zinc oxide, U. S. P.	lb.	—	.19 – .21
Zinc sulphate	lb.	.03½ – .03¾	.04 – .04½

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.00 — $1.10
Alpha naphthol, refined	lb.	1.40 — 1.60
Alpha naphthylamine	lb.	.40 — .50
Aniline oil, drums extra	lb.	.34 — .45
Aniline salts	lb.	.42 — .48
Anthracine, 80% in drums (100 lb.)	lb.	.90 — 1.00
Benzaldehyde (f.f.c.)	lb.	2.00 — 2.10
Benzidine, base	lb.	1.25 — 1.35
Benzidine, sulphate	lb.	1.20 — 1.25
Benzoic acid, U.S.P.	lb.	.90 — 1.10
Benzoate of soda, U.S.P.	lb.	.80 — 1.00
Benzol, pure, water-white, in drums (100 lb.)	gal.	.27 — .36
Benzol, 90%, in drums (100 lb.)	gal.	.25 — .31
Benzyl chloride, 95-97%, refined	lb.	.35 — .40
Benzyl chloride, tech	lb.	.25 — .35
Beta naphthol benzoate	lb.	.50 — .65
Beta naphthol, sublimed	lb.	.70 — .90
Beta naphthol, tech	lb.	.45 — .55
Beta naphthylamine, sublimed	lb.	2.25 — 2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 — .18
Ortho-cresol, in drums (100 lb.)	lb.	.23 — .25
Cresylic acid, 97-99%, straw color, in drums	gal.	.95 — 1.10
Cresylic acid, 95-97%, dark, in drums	gal.	.85 — 1.00
Cresylic acid, 50%, first quality, drums	gal.	.60 — .70
Dichlorbenzol	lb.	.08 — .10
Diethylaniline	lb.	1.40 — 1.50
Dimethylaniline (nominal)	lb.	— —
Dinitrobenzol	lb.	.30 — .37
Dinitroclorbenzol	lb.	.25 — .30
Dinitronaphthaline	lb.	.45 — .55
Dinitrophenol	lb.	.34 — .36
Dinitrotoluol	lb.	.40 — .45
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38 — .40
Diphenylamine (nominal)	lb.	.55 — .65
H-acid (nominal)	lb.	1.90 — 2.00
Metaphenylenediamine	lb.	1.15 — 1.80
Monochlorbenzol	lb.	.10 — .12
Monoethylaniline	lb.	1.70 — 1.85
Naphthaline crushed, in bbls. (250 lb.)	lb.	.08 — .09
Naphthaline, flake	lb.	.09 — .10
Naphthaline, balls	lb.	.10½ — .11
Naphthionic acid, crude	lb.	.70 — .85
Nitrobenzol	lb.	.14 — .19
Nitro-naphthaline	lb.	.40 — .50
Nitro-toluol	lb.	.20 — .30
Ortho-amidophenol	lb.	3.75 — 4.25
Ortho-dichlor-benzol	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.80 — 1.25
Ortho-nitro-toluol	lb.	.25 — .40
Ortho-toluidine	lb.	.25 — .45
Para-amidophenol, base	lb.	2.50 — 3.50
Para-amidophenol, HCl	lb.	2.50 — 3.25
Para-dichlor-benzol	lb.	.08 — .12
Paranitraniline	lb.	1.00 — 1.35
Para-nitro-toluol	lb.	1.35 — 1.50
Paraphenylenediamine	lb.	2.60 — 3.00
Paratoluidine	lb.	2.00 — 2.50
Phthalic anhydride	lb.	.65 — .75
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12 — .25
Pyridin	gal.	2.00 — 2.50
Resorcin, technical	lb.	4.25 — 4.50
Resorcin, pure	lb.	6.25 — 6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.50 — .52
Salicylic acid, U. S. P.	lb.	.55 — .60
Salol	lb.	.90 — 1.00

Solvent naphtha, water-white, in drums, 100 gal.	gal.	$0.25 —	$0.31
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19 —	.24
Sulphanilic acid, crude	lb.	.25 —	.30
Toluidine	lb.	1.70 —	2.50
Toluidine, mixed	lb.	.45 —	.55
Toluol, in tank cars	gal.	.28 —	.....
Toluol, in drums	gal.	.29 —	.32
Xylidine, drums, 100 gal.	lb.	.44 —	.50
Xylol, pure, in drums	gal.	.37 —	.45
Xylol, pure, in tank cars	gal.	.35 —	.....
Xylol, commercial, in drums, 100 gal.	gal.	.37 —	.45
Xylol, commercial, in tank cars	gal.	.23 —	.27

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.38 —	$0.39
Beeswax, refined, light	lb.	.40 —	.41
Beeswax, white pure	lb.	.63 —	.68
Carnauba, No. 1 (nominal)	lb.	.80 —	.88
Carnauba, No. 2, regular (nominal)	lb.	.60 —	.70
Carnauba, No. 3, North Country (nominal) . . †	lb.	.43 —	.45
Japan	lb.	.19 —	.20
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	..... —	.10
Paraffine waxes, crude, scale 124-126 m.p.	lb.	..... —	.11
Paraffine waxes, refined, 118-120 m.p.	lb.	..... —	.10½
Paraffine waxes, refined, 128-130 m.p.	lb.	.11 —	.11½
Paraffine waxes, refined, 133-135 m.p.	lb.	.12 —	.13
Paraffine waxes, refined, 135-137 m.p.	lb.	.13½ —	.14
Stearic acid, single pressed	lb.	.26 —	.27
Stearic acid, double pressed	lb.	.32 —	.29
Stearic acid, triple pressed	lb.	.32 —	.33

NOTE—Quotations on paraffine waxes are nominal.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1.65
Pine oil, pure, dest. dist.	gal.	.....
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.38
Pine tar oil, double ref., sp. gr. 0.965-0.990	gal.	.85
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.75
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref.	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	$17.95 —	$19.50
Rosin E-I	280 lb.	19.75 —	20.00
Rosin K-N	280 lb.	20.75 —	21.95
Rosin W. G.-W. W.	280 lb.	22.00 —	24.00
Wood rosin, bbl.	280 lb.	15.50 —	18.50
Spirits of turpentine	gal.	..... —	2.30
Wood turpentine, steam dist.	gal.	..... —	2.25
Wood turpentine, dest. dist.	gal.	..... —	2.00
Pine tar pitch, bbl.	200 lb.	8.40 —	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50 —	15.00
Retort tar, bbl.	500 lb.	15.00 —	15.50
Rosin oil, first run	gal.	.92 —	.95
Rosin oil, second run	gal.	.94 —	.97
Rosin oil, third run	gal.	1.10 —	1.15
Rosin oil, fourth run	gal.	1.17 —	1.18

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.33½
70-72 deg., steel bbls. (85 lb.)	gal.	.31½
68-70 deg., steel bbls. (85 lb.)	gal.	.30½
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.23½

Crude Rubber

Para—Upriver fine	lb.	$0.40½ —	$0.42
Upriver coarse	lb.	.30½ —	.32
Upriver caucho ball	lb.	.32½ —	.33
Plantation—First latex crepe	lb.	.47½ —	.48½
Ribbed smoked sheets	lb.	.47 —	.48
Brown crepe, thin, clean	lb.	.45 —	.....
Amber crepe No. 1	lb.	.46 —	.47

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.19 —	$0.20
Castor oil, AA, in bbls.	lb.	.20 —	.23
China wood oil, in bbls.	lb.	.24½ —	.25½
Cocoanut oil, Ceylon grade, in bbls.	lb.	.18½ —	.19
Cocoanut oil, Cochin grade, in bbls.	lb.	.19½ —	.20
Corn oil, crude, in bbls.	lb.	.17½ —	.18
Cottonseed oil, crude (f.o.b. mill)	lb.	.17½ —	.18
Cottonseed oil, summer yellow	lb.	.18½ —	.19
Cottonseed oil, winter yellow	lb.	.21 —	.23
Linseed oil, raw, car lots	gal.	1.84 —	.....
Linseed oil, raw, tank cars	gal.	1.77 —	.....
Linseed oil, boiled, car lots	gal.	1.87 —	.....
Olive oil, commercial	gal.	2.50 —	3.00
Palm, Lagos	lb.	.16 —	.16½
Palm, bright red	lb.	.15½ —	.17½
Palm, Niger	lb.	.15 —	.17½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.20½ —	.22
Peanut oil, refined, in bbls.	lb.	.27 —	.28
Rapeseed oil, refined in bbls.	gal.	1.64 —	1.70
Rapeseed oil, blown, in bbls.	gal.	1.64 —	1.68
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.19 —	.23
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.15½ —	.16

FISH

Winter pressed Menhaden	gal.	$1.17 —	$1.18
Yellow bleached Menhaden	gal.	1.20 —	1.22
White bleached Menhaden	gal.	1.23 —	1.24
Blown Menhaden	gal.	1.30 —	1.35

† (See New York market letter)

Miscellaneous Materials

All Prices f.o.b., N. Y.

Barytes, domestic, white, floated	ton	$38.00 —	$40.00
Barytes, off color	ton	20.00 —	25.00
Blanc fixe, dry	lb.	.04½ —	.05½
Blanc fixe, pulp	ton	30.00 —	50.00
Casein	lb.	..... —	.....
Chalk, English, extra light	lb.	.05 —	.07
Chalk, English, light	lb.	.04½ —	.06
Chalk, English, dense	lb.	.04 —	.05
China clay (Kaolin), imported, lump	ton	25.00 —	35.00
China clay (Kaolin), imported, powdered	ton	30.00 —	60.00
China clay (Kaolin), domestic, lump	ton	10.00 —	20.00
China clay (Kaolin), domestic, powdered	ton	25.00 —	40.00
Feldspar (nominal)	ton	13.50 —	18.00
*Fluor spar, acid grade, lump, f.o.b. mines	net ton	30.00 —	45.00
*Fluor spar, acid grade, ground, f.o.b. mines	net ton	55.00 —	65.00
Fuller's earth, domestic, powdered	ton	25.00 —	30.00
Fuller's earth, imported, powdered	ton	35.00 —	40.00
Graphite, crucible, 85% carbon content	lb.	..... —	.07½
Graphite, crucible, 86% carbon content	lb.	..... —	.08
Graphite, crucible, 87% carbon content	lb.	..... —	.08½
Graphite, crucible, 88% carbon content	lb.	..... —	.09
Graphite, crucible, 89% carbon content	lb.	..... —	.09½
Graphite, crucible, 90% carbon content	lb.	..... —	.10
Graphite, crucible, 91% carbon content	lb.	..... —	.10½
Graphite, crucible, 92% carbon content	lb.	..... —	.11
Graphite, crucible, plus 92%	lb.	..... —	.12½
Pumice stone, imported	lb.	.03 —	.06
Pumice stone, domestic	lb.	.02½ —	.....
Shellac, orange, fine nominal	lb.	1.45 —	.....
Shellac, orange, superfine	lb.	1.60 —	1.65
Shellac, A. C. garnet	lb.	1.30 —	1.35
Soapstone	ton	15.00 —	25.00
Talc, domestic	ton	20.00 —	60.00
Talc, imported	ton	60.00 —	70.00

*Nominal

Refractories

Following prices are f.o.b. works:

Chrome brick	net ton	75-80 at Chester, Penn.
Chrome cement	net ton	45-50 at Chester, Penn.
Clay brick, 1st quality fireclay	1,000	45-50 at Clearfield, Penn.
Clay brick, 2nd quality	1,000	40-45 at Clearfield, Penn.
Magnesite, dead burned	net ton	50-55 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80-85 at Chester, Penn.
Silica brick	1,000	50-55 at Mt. Union, Penn.

Ferro-Alloys

All Prices f. o. b. works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —	$250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon	lb.	.20 —	.21
Ferro-chrome, per lb. of Cr. contained, 2-4% carbon	lb.	.21 —	.22
Ferro-manganese, 70-80% Mn.	gross ton	180.00 —	240.00
Spiegeleisen, 16-20% Mn.	gross ton	60.00 —	65.00
Ferro-molybdenum, per lb. of Mo.	lb.	2.25 —	2.75
Ferro-silicon, 50%	gross ton	80.00 —	90.00
Ferro-silicon, 75%	gross ton	150.00 —	200.00
Ferro-silicon, 10-15%	gross ton	60.00 —	65.00
Ferro-tungsten, 70-80%, per lb. of contained W.	lb.	.90 —	1.10
Ferro-uranium, 35-50% of U	lb.	7.00 —	.....
Ferro-vanadium, 30-40% per lb. of contained V.	lb.	6.50 —	7.50

Ores and Semi-finished Products

All Prices f. o. b. Mines

Chrome ore, 35-40%, Cr_2O_3	unit	$0.70 —	$0.85
Chrome ore, 48% and over	unit	1.00 —	1.25
*Coke, foundry, f.o.b. ovens	net ton	7.00 —	.....
*Coke, furnace, f.o.b. ovens	net ton	6.00 —	.....
Petroleum coke, refinery, Atlantic seaboard	net ton	..... —	14.00
Fluor spar, gravel, f.o.b. mines	net ton	25.00 —	30.00
Manganese ore, 45% Mn and over	unit	.75 —	.85
Manganese ore, chemical (MnO_2)	gross ton	80.00 —	90.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.75 —	.85
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	7.00 —	10.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	6.50 —	7.50
Uranium oxide, 96%	lb.	2.75 —	3.00
Vanadium pentoxide, 99%	lb.	6.00 —	.....
Pyrites, foreign, lump	unit	.17 —	.....
Pyrites, foreign, fine	unit	.17 —	.....
Pyrites, domestic, fine	unit	.16 —	.17½
Ilmenite, 52% TiO_2	lb.	.02 —	.....
Rutile, 95% TiO_2	lb.	.11 —	.....
Carnotite, minimum 2% U_3O_8, per lb. of U_3O_8	lb.	2.75 —	3.00
Zircon, washed, iron free	lb.	.10 —	.....
Monazite, per unit of ThO_2	unit	42.00 —	.....

*Government prices.

Structural Steel

Mill, Pittsburgh

Beams and channels, 3 to 15-in.	100 lb.	$2.45
Angles, 3 to 6-in., ¼-in. thick	100 lb.	2.45
Tees, 3-in. and larger	100 lb.	2.45
Plates	100 lb.	2.65
Rivets, structural, ½-in. and larger	100 lb.	4.20
Rivets, conehead for boilers, ½-in. and larger	100 lb.	4.30
Sheets, No. 28 black	100 lb.	4.85
Sheets, No. 10 blue annealed	100 lb.	4.00
Sheets, No. 28 galvanized	100 lb.	6.20

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; for galvanized corrugated sheets, add 15c., all gages.

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

BIRMINGHAM—The Dixie Brass & Fdry. Co., 6th Ave. North, between 12th and 13th Sts., is in the market for portable electric welding outfits, lathes, drill presses, and general machine shop, iron and brass foundry tools and equipment.

California

EL MONTE—The city has awarded the contract for the construction of a sewer system and Imhoff septic tank, to McNeil & Barnett, 234 South Center St., Orange, at $41,813. Noted March 17.

OAKLAND—The Palmolive Co., 42 4th St., Milwaukee, Wis., is having plans prepared for the construction of an oil mill. Estimated cost, $500,000. Lockwood, Greene & Co., 38 South Dearborn St., Chicago, engrs. Noted March 3.

SACRAMENTO—The Southern Pacific Ry. Co., 65 Market St., San Francisco, is having plans prepared for the construction of a brass foundry, here.

SAN FRANCISCO—The Natl. Carbon Co., Brannan and 8th Sts., has awarded the contract for the construction of a 4-story, 175x275-ft. warehouse, etc., to Hannah Bros., 142 Sansome St., at $362,500.

WILMINGTON—The Vegetable Oil Products Co., Wilmington, Del., is negotiating for a site upon which to build a refinery, the first unit of which will cost about $300,000. Edward G. Mueller, dir.

Connecticut

BRIDGEPORT—The Harvey Hubbell, Inc., Bostwick Ave., plans to build a 4-story manufacturing plant on State St. Estimated cost, $175,000.

MERIDEN—The Miller Bros. Cutlery Co., 464 Pratt St., has awarded the contract for the construction of a 4-story, 50x90-ft. manufacturing plant addition on Pratt St., to the J. H. Grozier Co., 721 Main St., Hartford. Estimated cost, $50,000. Noted March 17.

Illinois

CHICAGO—B. Kuppenheimer & Co., 423 South Franklin St., is building a 3-story factory building at 20th St. and South Karlov Ave. Estimated cost, $500,000.

CHICAGO—The Troco Nut Butter Co., 30 North Michigan Ave., has awarded the contract for the construction of a 4-story, 100x112-ft. factory at 37th and Iron Sts., to E. W. Sproul Co., 2001 West 39th St. Estimated cost, $250,000. Noted March 31.

WOODRIVER—The Standard Oil Co., Syndicate Trust Bldg., St. Louis, Mo., plans to construct a lubricating oil plant in addition to the other large projects, at its plant, here.

Indiana

TERRE HAUTE—The Columbian Enameling & Stamping Co. has awarded the contract for the construction of a 1-story, 155x240-ft. factory, to Roehm Bros., Denning Bldg. Estimated cost, $100,000.

Kansas

SCOTT CITY—The city will receive bids about May 1 for the construction of a sanitary sewerage system and a sewage disposal plant. Estimated cost, $75,000. Ruckel Eng. Co., Hutchinson, engr.

Kentucky

LOUISVILLE — The Visible Measure Gasoline Dispenser Co., 700-800 West Breckinridge St., plans to build a 2-story factory addition at 8th and Breckinridge Sts. Estimated cost, $25,000. G. Cunningham, genl. mgr.

Maryland

ASBESTOS—Arthur E. Van Bibber, 6337 Drexel Rd., Philadelphia, Pa., has purchased the plant of the Baltimore Roofing & Asbestos Mfg. Co., here, and plans to use same for the manufacture of linoleum and roofing.

BALTIMORE—The Amer. Sugar Refining Co., 117 Wall St., New York City, has awarded the contract for the construction of a sugar refinery including several 5- to 8-story buildings at Locust Point harbor front, to Stone & Webster, 117 Wall St., New York City. Estimated cost, $8,000,000.

BALTIMORE—S. W. Wiley & Co., Inc., analytical and consulting chemists, 7 South Gay St., is having plans prepared for the construction of a 3-story, 50x122-ft. chemical laboratory at 900-904 North Calvert St. Estimated cost, $150,000. W. G. Beecher, Frederick Rd., Catonsville, archt.

CURTISS BAY (Baltimore P. O.)—The Prudential Oil Co., Inc., 310 Keyser Bldg., Baltimore, will soon receive bids for the construction of a 1-story, 72x129-ft. oil refinery on 3rd and 4th Aves. Estimated cost, $25,000.

DUKES (Adelina P. O.)—The West Virginia Pulp & Paper Co., 200 5th Ave., New York City, will build 50x90-ft. and 100x120-ft. additions to its plant. Work will be done by day labor. Noted March 23.

Massachusetts

BROCKTON—George L. Falk, archt., 63 Main St., will soon award the contract for the construction of a 3-story, 55x160-ft. dry kiln building on Cherry St., for the Miller Tree Co. Estimated cost, $50,000.

CAMBRIDGE—The Prest-O-Lite Co., Inc., 30 East 42nd St., New York City, is having plans prepared for the construction of a few 1-story, 25x100-ft. acetylene plants. Estimated cost, $80,000.

CHICOPEE—The Fiske Rubber Co. has awarded the contract for the construction of 2-, 3- and 5-story factory additions, to Fred T. Ley, 19 West 44th St., New York City. Estimated cost, $150,000.

WEST SPRINGFIELD (Springfield P. O.)—The Gilbert & Barker Mfg. Co., Cold Springs Ave., has awarded the contract for the construction of 12 buildings, including a 2-story, 80x400-ft. brass foundry, 1-story, 40x80-ft. zinc building, 2-story, 164x200-ft. sheet metal building and a 1-story, 14x63-ft. testing building, to Tucker & Lewis, Inc., 101 Park Ave., New York City. Estimated cost, $1,000,000. Noted March 10.

Michigan

DETROIT — Albert Kahn, archt., Marquette Bldg., will receive bids until April 15 for the construction of a 1-story, 175x282-ft. factory on Mt. Elliott and Strong Aves., for the Detroit Pressed Steel Co., 1800 Mt. Elliott Ave.

DETROIT—The Wolverine Auto Painting & Trimming Co., c/o Atwood & Trysell, archts., 603 Temple Bldg., is having plans prepared for the construction of a 2-story, 90x100-ft. enameling plant at Herbert and Martin Sts. Enameling and painting equipment will be installed in same. Estimated cost, $25,000.

GOODELLS—The Brass & Aluminum Fdry. Co. is in the market for a brass furnace.

MILAN—The Amer. Furnace & Fdry. Co. has awarded the contract for the construction of a 1-story, 75x200-ft. foundry along the Michigan Central R.R., to Thomas Gotts. Estimated cost, $50,000.

Minnesota

RENVILLE — The Bd. Educ. plans to build a 2-story, 80x240-ft. junior and senior high school. A chemical laboratory will be installed in same. Estimated cost, $300,000. Croft & Boerner, Palace Bldg., Minneapolis, archts. and engrs.

Missouri

MAPLEWOOD (St. Louis P. O.)—The Bowen Motor Car Co., Title Guaranty Bldg., has purchased a 21-acre site here and plans to build a plant for the manufacture of gasoline driven standard gage railway cars, on same.

ST. LOUIS—The Century Electric Co., 18th and Pine Sts., is building a factory. Estimated cost, $500,000. Noted Jan. 21.

Montana

FORSYTHE—The Bd. Educ. plans to build a high school. A chemical laboratory will be installed in same. Findlay & Ferrier, archts.

New Jersey

NEWARK—The General Lead Batteries, 123 West 56th St., New York City, will build a 5-story factory at Lester Ave. and Chapel St. Estimated cost, $150,000. Work will be done by day labor. Noted Feb. 11.

NEWARK—The Hanovia Chemical & Mfg. Co., Chestnut St. and the New Jersey R.R., has awarded the contract for the construction of a 3-story, 40x75-ft. chemical factory, to the Becher Constr. Co., 361 Grove St.

NEWARK—The Simms Magneto Co., North Arlington Ave., East Orange, has awarded the contract for the construction of a 2-story, 177x231-ft. addition to its present building on North Arlington Ave., to the Amer. Concrete Steel Co., 27 Clinton St. Estimated cost, $385,000.

NEW BRUNSWICK—The Trenton Porcelain Co., 803 East State St., has awarded the contract for the construction of a 1-story, 30x150-ft. porcelain plant, to F. R. Parker, 327 Calhoun St., Trenton. Estimated cost, $20,000. Noted Feb. 11.

TRENTON—The Cook Linoleum Co., East State St., has awarded the contract for the construction of a 1-story, 79x169-ft. plant addition, to J. H. Morris, Broad St. Bank, at $50,000.

TRENTON—The Nearpara Rubber Co., 79 Prince St., has awarded the contract for the construction of a 1-story, 100x125-ft. rubber plant, etc., to the Bethlehem Constr. Co., Bethlehem Trust Bldg., Bethlehem, Pa. Estimated cost, $150,000.

New York

ALBANY—The Albany Perforated Wrapping Paper Co., 1271 B'way., plans to build a 1-story addition to its plant. Estimated cost, $210,000.

BROOKLYN—The Keystone Varnish Co., 71 Otsego St., is having plans prepared for the construction of a 4-story, 50x100-ft. factory addition at 73 Otsego St. Estimated cost, $85,000. John E. Nitchie, 63 Park Row, New York City, archt. and engr.

BUFFALO—The Dept. of Pub. Wks. will receive bids until April 17 for the delivery of 80,000 lb. of liquid chlorine between May 1, 1920, and May 1, 1921.

BUFFALO—The Globe Belting Co. plans to construct a manufacturing plant at 1396 Clinton St. Estimated cost, $15,000.

BUFFALO—The Interlocking Reinforced Concrete Corp., East Ferry St. and the Erie R.R., has awarded the contract for the construction of a 1-story, 125x600-ft. factory, to J. Bellony, Builders' Exch. Bldg. Estimated cost, $25,000.

DUNKIRK—The Atlas Crucible Steel Co. plans to build a 70x200-ft. electric melting building, annealing buildings, etc., at its plant here. A 6-ton Heroult furnace, a 26-in. rolling mill and a 16-in. rolling mill, as well as other heating and annealing furnaces, etc., will be installed in same. This plant when completed will include three 30-pot furnaces, two 6-ton and one 3-ton Heroult electric furnaces, one 20-ton basic hearth furnace, hammers, rolling mills, wire mill, laboratory, inspection and shipping departments. Estimated cost, $1,800,000.

EAST SYRACUSE (Syracuse P. O.)—The East Syracuse Live Stock Rendering & Fertilizing Co., Inc., has purchased a site here and plans to construct a large packing plant on same. H. T. Riley, pres.

GOWANDA—The Eastern Tanners' Glue Co. plans to build an addition to its factory, here.

HAMBURG—The village is having plans prepared for the construction of a sewerage system and a sewage disposal plant. A $250,000 bond issue has been passed for the project.

LONG ISLAND CITY—Fahnestock Electric Co., Skillman Ave., has awarded the contract for the construction of a 2-story, 50x100-ft. factory at East Ave. and 8th St., to C. C. Woodruff, 213 10th Ave. Estimated cost, $52,000.

PYRITES—The De Grasse Paper Co. had plans prepared for the construction of a 1-story, 60x208-ft. machine room at its plant, here. Estimated cost, $150,000.

THERESA—The Orleans Four Corners Dairymen's League Co-operative Association, Inc., is in the market for milk-handling machinery, refrigeration system and milk-testing laboratory equipment.

TONAWANDA—T. J. Ballary, engr., will receive bids until May 5 for the construction of a filtration plant for the city. Estimated cost, $200,000.

Nevada

MINA—The Olympic Mines Co. plans to build a new mill on the site of the old one, which was destroyed by fire. The mill will have a capacity of 75 tons and will treat the ores from both the Olympic and the Loo mines. Estimated cost, $100,000.

North Carolina

HICKORY—The mayor has awarded the contract for the construction of a sewage disposal plant, to Tucker & Laxton, Inc., Charlotte, at $21,000.

North Dakota

HANKINSON—The Bd. Educ. will install a chemical laboratory in the proposed high school here.

Ohio

CINCINNATI—The Amer. Can Co., 120 B'way., New York City, plans to construct several 1- and 3-story factory buildings on Fergus St. Estimated cost, $1,000,000.

CINCINNATI—The Standard Silicate Co. has awarded the contract for the construction of a 2-story, 98x160-ft. and a 1-story, 49x80-ft. factory building on Paddock Rd., to the Fisher De Vors Co., 36 Blymyer Bldg. Estimated cost, $750,000. Noted March 17.

CLEVELAND—The Bd. Educ., East 6th St. and Rockwell Ave., plans to build a 3-story high school at the University Circle. Chemical equipment will be installed in same. Estimated cost, $5,000,000. F. G. Hogan, dir. U. R. McCormack, East 6th St. and Rockwell Ave., archt.

CLEVELAND—The Carbonized Steel Products Co., 331 East 140th St., has awarded the contract for the construction of a 1-story, 40x60-ft. factory, to the Sam Emerson Co., 1900 Euclid Ave. Estimated cost, $6,000.

CLEVELAND—The Euclid Fdry. Co., c/o Hulett & Stanton, archts., 226 West Superior Ave., has awarded the contract for the construction of a 1-story, 125x140-ft. foundry on St. Clair Ave. and the New York Central R.R., to the Complete Constr. Co., 226 West Superior Ave. Estimated cost, $100,000.

EAST CLEVELAND (Cleveland P. O.)—The Natl. Lamp Co. of the General Electric Wks., Nela Park, has awarded the contract for the construction of a 1-story, 100x220-ft. laboratory at Nela Park, to the Austin Co., 16112 Euclid Ave., Cleveland. Estimated cost, $100,000.

ELYRIA—H. A. Beck, Dir. of Pub. Serv., City Hall, will receive bids until April 26 for the construction of a filtration plant, substructures and appurtenant works, including coagulating basin, filtered water reservoir, rapid sand filter tanks, etc.

TRUMBULL—The Bd. Educ. R.F.D. 3, Youngstown, is having plans prepared for the construction of a 2-story, 91x150-ft. school on Churchill Rd. Chemical laboratory equipment will be installed in same. Estimated cost, $150,000. C. Cliffe, clk. Miller & Son, 408 Dollar Bank Bldg., Youngstown, archts.

WARREN — The General Fire Extinguisher Co. has awarded the contract for the construction of a 2-story, 100x200-ft. foundry, to the Foundation Co., 233 B'way., New York City. Complete foundry equipment will be installed in same. Estimated cost, $350,000.

Pennsylvania

HARRISBURG—The Harrisburg Water Dept. plans to install 6 additional filters, etc., at the filtration plant. S. F. Hassler, comr.

WHEATLAND—The Slick Knox Steel Co., c/o W. L. Ulmer, dir., Hippodrome Bldg., Cleveland, O., plans to construct a 1-story steel mill. Estimated cost, $300,000.

Texas

BRYAN—The city has awarded the contract for the construction of a sewerage system and a sewage disposal plant in the eastern section of the city, to F. L. Young, 306 Pershing Ave., San Antonio. Estimated cost, $35,844.

Wisconsin

CARROLLVILLE—The United States Glue Co. has awarded the contract for the construction of a 3-story, 377x500-ft. food manufacturing plant, to Paul Riesen's Sons, 1018 Humboldt Ave., Milwaukee. Estimated cost, $2,000,000. Noted March 10.

KOHLER—The Kohler Co. will build a 1-story, 100x290-ft. foundry. Work will be done by day labor.

MILWAUKEE—The Trapp Bros. Dairy Co., 86 Burleigh St., has awarded the contract for the construction of a 2-story, 70x110-ft. dairy on Burleigh St., to the R. Reisinger Co., 425 East Water St. Estimated cost, $75,000.

WEST ALLIS—The Allis-Chalmers Mfg. Co. has awarded the contract for the construction of a 1-story, 130x500-ft. foundry, to Klug & Smith, 40 Mack Block, Milwaukee. Estimated cost, $200,000.

West Virginia

CLARKSBURG—The city has awarded the contract for building an intake chamber and installing coagulating basins and equipment for pumping station, to the Richards Constr. Co., at $37,108.

Ontario

HAMILTON—T. B. McQuestin, Chn. of the Civic Gas Committee, has recommended that the city build a gas manufacturing plant. Estimated cost, $3,000,000. E. R. Gray, City Hall, engr.

KITCHENER — The Young Business Men's Association plans to construct a large hockey and skating arena. Chemical equipment required in connection with ice making will be installed in same. Estimated cost, $250,000.

Quebec

MONTREAL—The Barrett Mfg. Co., 2004 St. Hubert St., is having plans prepared for the construction of an addition to its tar products plant. Estimated cost, $32,000.

Coming Meetings and Events

THE AMERICAN ASSOCIATION OF ENGINEERS will hold its fifth annual convention at the Planters Hotel in St. Louis, May 10 and 11.

THE AMERICAN CHEMICAL SOCIETY will hold its annual meeting April 13 to 16 inclusive at St. Louis. Headquarters will be at the Hotel Statler.

THE AMERICAN ELECTROPLATERS' SOCIETY will hold its eighth annual convention in Rochester, June 30 to July 3. Headquarters will be at the Seneca Hotel.

THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its semi-annual meeting in Montreal, June 21 and 22; Ottawa, June 23; Shawinigan, June 24 and 25, and La Tuque, June 26.

THE AMERICAN IRON AND STEEL INSTITUTE will hold its spring meeting May 28 at the Hotel Commodore, New York City.

THE AMERICAN SOCIETY FOR TESTING MATERIALS will hold its annual meeting at Asbury Park, N. J., June 22 to 25.

THE AMERICAN ZINC INSTITUTE will hold its spring meeting May 10 and 11 at the Congress Hotel, Chicago, Ill.

THE CHAMBER OF COMMERCE OF THE U. S. announces that its eighth annual meeting will be held at Atlantic City, April 27 to 29, the subject of which will be "Increased Production."

THE CHEMICAL SOCIETY OF THE COLLEGE OF THE CITY OF NEW YORK is pleased to announce the following lectures for the spring semester of 1920 to be delivered in the Doremus Lecture Theater: "Water Supply and Drainage in War Cantonments," Wednesday, April 21, at 4 p.m., Prof. D. D. Jackson, administrative head, department of chemical engineering, Columbia University (*Lantern*); "Modern Coke and Gas Manufacture" (Koppers Process), Thursday, April 29, at 4 p.m., E. L. Crowe (*Lantern and cinema*); "Chemical Naval Warfare," Friday, May 7, at 4 p.m., Prof. James Kendall, professor of chemistry at Columbia University; "Fighting Fire—Firefoam," Friday, May 14, at 4 p.m., F. A. Epps, chief engineer, the Foamite Firefoam Co. (*Experimental, cinema and lantern.*)

THE INSTITUTE OF METALS DIVISION OF THE A.I.M.E., will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

THE IRON AND STEEL INSTITUTE (London) will hold its annual meeting May 6 and 7, 1920, at the House of the Institute of Civil Engineers, Great George St., London, S. W. 1. The retiring president, Eugene Schneider, will induct into the chair Dr. J. E. Stead, the president-elect.

THE MINE INSPECTORS' INSTITUTE OF AMERICA will hold a meeting at Cleveland, Ohio, July 13, 14 and 15.

THE MINING SOCIETY OF NOVA SCOTIA has planned a meeting for May 4 and 5 which will be held in Glace Bay.

THE SIXTH NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES will be held in the Grand Central Palace, New York City, Sept. 20 to 25.

THE NATIONAL FERTILIZER ASSOCIATION will hold its twenty-seventh annual convention at the Greenbrier, White Sulphur Springs, W. Va., the week of June 21.

THE NATIONAL FOREIGN TRADE CONVENTION will be held in San Francisco, May 12 to 15. Chinese delegates have chartered the S. S. Ecuador for transportation to this conference.

THE NATIONAL SAFETY COUNCIL, Engineering Section, will hold its spring conference in the Engineering Societies Building, New York City, on April 27.

THE NEW JERSEY CHEMICAL SOCIETY plans the following: Saturday, April 24, 2:30 p.m., visit to the plant of the Raritan Copper Co., Perth Amboy, N. J.; Monday evening, May 10, regular meeting; Saturday afternoon and evening, June 5, at Rutgers College, New Brunswick, N. J., regular meeting and ladies' day.

THE NITROGLYCERINE MANUFACTURERS' ASSOCIATION will hold a meeting in Chicago, April 19 and 20.

THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its spring meeting at the Hotel Waldorf and the Hotel Astor, New York City, April 12 to 16.

Industrial Notes

HARRY J. WOLF, formerly associate editor of *Engineering and Mining Journal*, announces that he has resumed the general practice of mining engineering, with office at 42 Broadway, New York City.

THE ROESSLER & HASSLACHER CHEMICAL Co. announces that the main office has been removed to 709-717 Sixth Ave., corner 41st St., New York City.

THE OXWELD ACETYLENE Co., of Newark, N. J., and Chicago, has recently extended its manufacture of oxy-acetylene apparatus and equipments to include "Eveready" welding and cutting outfits. "Eveready" is a new name in the oxy-acetylene field, but the apparatus is not new, excepting for certain refinements of design, having been used extensively in the metal-working trades for several years under the name of "Prest-O-Lite" apparatus. The new name was adopted by the Oxweld company to suggest the ready convenience, adaptability and general-purpose uses of the equipment. The apparatus is designed for use exclusively with compressed acetylene in cylinders, thus providing the welder and cutter a compact and complete portable outfit.

CHARLES C. PHELPS has become associated with the Uehling Instrument Co., 71 Broadway, New York, combustion engineer and manufacturer of CO_2 recording equipment and other fuel economy apparatus. He is devoting most of his attention to research work in connection with the efficient combustion of fuel oil in boiler furnaces. Mr. Phelps graduated from Stevens Institute of Technology with the degree of mechanical engineer and has since spent several years studying power-plant problems. For five years of this period he was connected with the Ingersoll-Rand Co., manufacturer of power-plant equipment and pneumatic machinery.

JOHN A. KIENLE, formerly sales manager of the Electro Bleaching Gas Co., has been appointed general manager of sales of the Mathieson Alkali Works, Inc. This change was brought about by the severing of relations between the Mathieson Alkali Works, Inc., and its former sales agent, Arnold, Hoffman & Co., Inc. It is the intention of the Mathieson Alkali Works, Inc., to sell all of its products (caustic soda, soda ash, virginia soda, bicarbonate of soda, bleaching powder, liquid chlorine, chlorine solvents, etc.) direct to the consumer instead of through sales agents. Mr. Kienle has been placed in charge of the development of a complete sales organization. E. E. Routh, formerly manager of bicarbonate sales, has been appointed assistant to Mr. Kienle.